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(b) sufficient mass. Will the Sun become a supernova? Mass and energy are two sides of the same coin. They are found in patches, and they seldom cover more than a small portion of the sky. In most atoms, the various fields cancel one another because the electrons spin in opposite directions. From the half-lives of uranium isotopes and the
percentage of lead isotopes in uranium-bearing rock, it is possible to calculate the date at which the rock was formed. For the remainder of this chapter, however, we will simply describe the different kinds of galaxies and how they are organized within the observable universe. This is evident for a broad, slow-moving river that flows more swiftly as it
enters a narrow gorge. Magnetic field Direction of wave travel Maxwell saw the link between electromagnetic waves and light. How does the Falkirk Wheel above, an alternative to a locks-and-canal system, use very little energy to rotate boats from a lower body of water to a higher one? This can be expressed by the formula Consider mixing 100 g of
25°C water with 75 g of 40°C water. For example, the common mineral quartz, SiO2, can be found in many colors, depending on slight impurities. Light enters through your pupil (the aperture, or opening, in the iris). We (a) cannot hear infrasonic or
ultrasonic sound waves.* But dogs and some other animals can. Suggest what might happen to the caffeine of a caffeinated beverage if the beverage was first made alkaline with sodium hydroxide and then shaken with some diethyl ether. Rank the following molecules in order of the phase they form at room temperature: solid, liquid, gas.
CHECKPOINT At a water treatment facility, how does adding slaked lime and aluminum sulfate to water purify the water? If not for refraction, submarines would be much easier to detect. With time, marble may dissolve from the conglomerate. How many more electrons can fit in the valence shell of a fluorine atom? This is because the average speed
of the ball in this interval is 3 m/s. Tiny particles, like tiny bells, scatter high-frequency waves more than low-frequency waves as an acid. Because too much would flush out dissolved ions that are absolutely essential for your health. (e) What is the
change in velocity, ©v, during this 1-s interval? You can imagine the axis as a plane extending downward into Earth, as Figure 21.31 6 shows. Table 8.1 describes the effects of different amounts of current on the human body. As a consequence, each element emits a distinctive glow when energized. The magnitude of G is identical to the magnitude of
the force between a pair of 1-kg masses that are 1 m apart: 0.00000000000667 N. The reverse argument holds for the basalt. THINKANDSOLVE (MATHEMATICALAPPLICATION) 51. Distilled water is pure only before you drink it. In the middle box, draw what these particles would look like if heat were taken away. Why does the
presence of large bodies of water tend to moderate the climate of nearby land—making it warmer in cold weather? What happens to the shape of a nebula as it contracts and spins faster? Discuss the differences in the properties of sound and light that this indicates. The north magnetic pole periodically reverses and becomes
the south magnetic pole, and vice versa. Integrated into this design are learning objectives appearing alongside each chapter section head. (d) atoms have greater electronegativity. The study of the overall structure and evolution of the universe is called cosmology. A B Was this your answer? (c) A silver spoon tarnishes. What happens to heat added to
a system that doesn't increase the temperature of the system? The environmental lapse rate varies with local conditions. The secondary has 100 turns. EXPLAIN THIS L ook up into the clear nighttime sky away from the city lights and you will see plenty of stars. Rank the following molecules from least oxidized to most oxidized: H H H C C H H H H
Ethane H H O C C H H H H Ethanol H O C C H Acetaldehyde H H H O C C O H Acetic aid E X E R C I S E S (SYNTHESIS) 51. This form of matter does not recognize the strong nuclear force, which means it cannot clump to form atomic nuclei. Faunal succession Fossil organisms succeed one another in a definite, irreversible, and determinable order.
The piano tuner should loosen the piano string. onsider a book lying at rest on a table. A magnetic field is produced by the motion in a common bar magnet? Resolve the misunderstanding underlying this question. Note that the lines emanate from the positive charge and terminate on the negative charge
small piece of U-235, neutrons leak through the surface before an explosion can occur. An oceanic depth-sounding vessel surveys the ocean bottom with ultrasonic waves that travel at 1530 m/s in seawater. The planets also have successfully cleared all debris from their orbital paths, which all lie roughly in the same plane. Scientific advance came to a
near halt in Europe when the Roman Empire fell in the 5th century AD. Two of the largest batholith in North America are the Coast Range batholith (Figure 20.23). P A R T F O U R Astronomy If I were standing on the Moon, I wonder what Earth would look like when the Moon passes into Earth's shadow—that is,
during a lunar eclipse. Fast-forward to the 21st century, and we've since learned that all the materials around us are made of remarkably small particles called atoms. Temperature, air pressure, humidity, types of clouds, level of precipitation, wind direction, and wind speed. Light illuminates the book, and light of some frequencies is subtracted from
the light reflected. (Physicists use the "right-hand rule." If the right thumb points in the direction of motion of a positive particle, then the curved fingers of that hand show the direction of the magnetic field. It can cause flooding. If you ever show different kinds of vectors on the same diagram, use different colors or some other method of
distinguishing the different kinds of vectors. The answer is yes to all questions. Just as a bow wave is produced by overlapping spheres that form a Cone. To the Student P H YSIC A L S CIENCE IS A BOU T T HE RU L E S OF T HE PH YSIC A L WOR LD — physics, chemistry, geology, and
astronomy. The easiest way to distinguish a suspension from a solution in the laboratory is to spin a sample in a centrifuge. HOOHH Dipole-dipole attraction (hydrogen bond) H FIGURE 15.34 The dipole-dipole attraction (between two water molecules is a hydrogen bond) H FIGURE 15.34 The dipole-dipole attraction (hydrogen bond) H FIGURE 15.34 The dipole attraction (hydrogen bond) H FI
oxygen atoms. So a chemist can predict which bonds are more polar than others without reading the electronegativities. After the reaction, these same six atoms are found in two O3 molecules. temperature? Some solar cells can convert 40% of the power, or about 400 W/m 2. Both the spinning motion and the orbital motion of every electron in an
atom produce magnetic fields. The hemispheres are not sucked together, nor is the piston holding the weight sucked upward. A man named Lester A. 20 miles A' Mauna Loa FYI Henderson Seamount 10 Composite volcanoes tend to erupt explosively because their magmas and lavas usually do not flow easily. Which has the higher specific heat
capacity: an object that cools quickly or an object that cools quickly or an object of the same mass that cools more slowly? 500 turns x turns 120 V 39. Born in Greece, he was the son of a physician who personally served the king of Macedonia. 5.7 Pascal's Principle EXPLAIN THIS How can small pressures in hydraulic machines produce large forces? Motion produces an additional
influence. C H A P T E R 10 10.1 Vibrations and Waves EXPLAIN THIS I How do vibrating electrons produce radio waves? FIGURE 5.43 Try this in your sink. No, internal forces don't affect the acceleration of the system. Suppose a gliding cart with a mass of 0.5 kg bumps into, and sticks to, a stationary cart that has a mass of 1.5 kg. The
mathematical structure of physics is evident in the many equations you will encounter throughout this book. In short, atoms are not well suited to graphical depictions. When the momentum of moving water or anything else is suddenly reduced, the impulse it exerts is relatively huge. We say average speeds, for the speed of light in a vacuum is a
constant 300,000 kilometers per second. 120 PARTONE PHYSICS LEARNING OBJECTIVE Distinguish among weight, mass, and density. The air cools at the dry adiabatic lapse rate of 10°C for each kilometer it rises. So acceleration involves a change in both speed and direction. Earth scientists are
considering a means of inducing clouds to be a brighter white. e, 2. Explain why you felt heat from the lamp. Stated another way, any object less dense than air rises in air. Some of the dissolved solids and gases give water its characteristic taste, and many of them promote human health: fluoride compounds protect teeth, chlorine destroys harmful
bacteria, and as much as 10% of our daily requirement of iron, potassium, calcium, and magnesium is obtained from drinking water (Figures 16.2 and 16.3). Geoscientists study the reflection, refraction, and speeds of the various types of seismic waves to piece together a story about Earth's interior. The temperature of the Sun's interior is about 107
degrees. The amount of redshift tells us how fast that galaxy is receding. Temperature, however, is defined by translational motion. 7.6 Heat Transfer and Change of Phase 17. A voltmeter is connected across a single bulb to measure the voltage drop across it. (a) From v = v0 + at, and with v0 = v0 + at, and v0 = v
2 * 9.8 * 12 = 4.9 m 3. In many instances, the ratio in which chemicals react is not 1:1. The closer it gets to you, however, the more apparent its intrinsic motion. Is glass transparent or opaque to light of frequencies? But a north magnetic pole never exists without the presence of a south pole, and vice versa.
This continuum is illustrated in Figure 15.24. Try it sideways. He bombarded nitrogen gas with alpha particles from a piece of radioactive ore. The final temperature? Some areas still haven't recovered. Heat a small amount
of water to boiling in an aluminum soft-drink can and invert the car guickly into a dish of cold water. Does enough wheat exist in the world to fill all 64 squares in this manner? When the car simultaneously pushes back on you, that force is on you—not the car. The sounds emitted by bats are extremely intense. From this we derive Fot = O(mv). (d)
The heated wax molecules combine with oxygen molecules. With the periodic table as your guide, describe the element selenium, Se, using as many of this chapter's key terms as you can. Show that the wavelength of these microwaves traveling at the speed of light is 10 cm. Which produces precipitation: a rising moist air mass, a descending moist air mass, a descending moist air mass.
mass, or both? The tornado can bounce and skip as it rises briefly from the ground and then touches back down again. How much energy is in a nut? MasteringPhysics Tutorials MasteringPhysics Tutorials guide students through important topics with self-paced tutorials that provide JOEJWJEVBMJ[FEDPBDIJOH)JOUTBSF
provided, and students are free to DIPPTFPOMZUIFTQFDJmDIFMQUIFZOFFE 4QFDJmDXSPOHBOTXFSGFFECBDLGPS common wrong answers helps students understand their misconceptions and guides them towards the correct answer. The greedy negative kid is twice as one of the positive kids is positive. Whether one material
dissolves in another is a function of their electrical attractions for each other. Rotational speed (sometimes called angular speed) refers to the number of rotations or revolutions per unit of time. Which of these pairs of elements are farthest apart in the periodic table? Which are older: the atoms in the body of an elderly person or the atoms in the body
of a baby? In a similar way, it is mainly people who are either uninformed or misinformed about the deeper natures of both science and religion who feel that they must choose between believing in religion and believing in science. Why is it important to have a science-based understanding of the structure of our universe? The natural flow of energy is
always a one-way trip from where it is concentrated to where it is concentrated out." That energy tends to disperse is spelled out by the second law of thermodynamics, which can be paraphrased as follows: Any process that happens by itself results in the net dispersal of energy. Air is an excellent insulator. A syncline folds downward
—it sags. Note that because gravity acts only vertically and there is no acceleration in the horizontal direction, the cannonball travels equal horizontal distances in equal times. 5.3 Buoyancy in a Liquid 9. Mountains sink until the upward buoyant force balances the downward gravitational force. Can you see Newton's laws at work here? Is aging
primarily an example of a physical or chemical change? The difference in wave speed causes the wave to turn. (d) response to solar energy. LEARNING OBJECTIVE Introduce the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire, they are the magnet exerts a force on the wire and the magnet exerts a force on the wire and the wire and the wire and the wire a force of the wire and the
wire, according to Newton's third law, must exert a force on the magnet. (c) The concentration of the reactants should be increased. Persons, places, and things have energy, but we usually observe energy only when it is being transferred or being transferred or
the mass in kilograms of 1 L of water? Temperatures recorded in mines and drill holes indicate that Earth's temperature increases throughout most of the continental crust at an average of 30°C for CHAPTER 20 t ien rad al g Depth (km) Temperature (°C) 200 400 600 800 1000 erm oth * The layer below Earth's crust, the mantle, behaves like an
elastic solid. What does this have to do with magnetism? Your challenge is to arrange the dominos so that every one of them falls. In the high temperatures of the Sun, approximately 657 million tons of hydrogen are converted into 653 million tons of hydrogen are convert
or a potassium ion from a chloride ion? Energy is transferred from the man to the load. * When a direction is assigned to rotational speed, we call it rotational speed, we call it rotational velocity (often called angular velocity). One of these fields increases the speed of the charged particles, and the other field causes them to follow a curved path. Read on! CHAPTER 7 7.1 H E AT
TRANSFERANDCHANGEOFPHASEConduction EXPLAINTHIS Why is a tile floor cooler to your feet than a rug of the same 165 LEARNING OBJECTIVE Describe the nature of conduction in solids. People often have a related illusion about the vertical height a human can jump. 1.4 Net Force EXPLAIN THIS How can mom and dad push
on something to produce a net FIGURE 1.9 One kilogram of nails weighs about 10 N, which is equal to 2.2 lb. Should the government require that certain materials be recycled? This is CMYK printing (K indicates black). In both cases, there is no contact between the bodies. Higher pressure (a) Pump Cross-section (b) (Figure 8.18a).
The brightest places in our visual field are prevented from outshining the rest, because whenever a receptor cell on our retina sends a strong brightness signal to our brain, it also signals neighboring cells to dim their responses. the mantle and core casts an S-wave shadow that is even more extensive than the P-wave shadow—S-waves are unable to
pass through the core. Hold it at a slight upward angle to show a version of Figure 4.17 (left). As it moves, it is deflected to the northeast in the Southern Hemisphere and to the southeast in the Southern Hemisphere. FYI The metals used for cathodic protection are "sacrificing" themselves to be anodes (to lose electrons) so that the desired metal,
such as the copper pipe, is spared from oxidation. The wavelengths of light in billionths of a meter (nanometers). Shown below is a crosssection of this structure. Earth's magnetic field induces some degree of magnetism in most of
the iron objects around you. We are grateful to Marshall Ellenstein and Diane Reindeau, who helped develop the new feature, Think and Rank. Try finding one yourself. Venus is the hottest planet in the solar system. In what direction has your constellation shifted? Sound cannot travel in a vacuum. A result of this lateral action is the stream's sinuous
form. When three projectors shine red, green, and blue light on a white screen, the overlapping parts produce different colors. Mix cubes of ice, butter, and cheese together with a little water, and put this mixture in the freezer. Here we will consider some ordinary examples in which impulse is related to increasing and decreasing momentum. At the
urging of the medical establishment, King Louis XVI appointed a royal commission to investigate Mesmer's claims. Superconductor because its magnetic field cannot penetrate the superconducting material. (a) (b) (c) FIGURE 26.2 This photograph, provided by
the Hubble Telescope, shows the Orion Nebula. TUTORIAL: Magnetic Fields (a) (b) * Interestingly, because motion is relative, the magnetic field is relative. (b) Earth rotates about its axis because living things need an alternation of light and darkness. Time FIGURE C.5 A curve showing the rate of consumption of a renewable resource such as
agricultural or forest products, where a steady rate of production and consumption can be maintained for a long period, provided this production is not dependent upon the use of a nonrenewable resource that is waning in supply. Copper transforms to patina. What happens when the can comes to an abrupt stop is worth watching! 34. It flows from
where it is concentrated to where it is spread out. As a result, the solution begin to escape into the carbon dioxide molecules that were once squeezed into the solution begin to escape into the solutions: 17.3
Step 3. If you know the mass in kilograms and want the weight in newtons, multiply the number of kilograms by 10. Wilson, working at Bell Labs in New Jersey, used a simple radio receiver to survey the heavens for radio signals (Figure 28.4). The age of the Dead Sea Scrolls was determined by carbon-14 dating. When voltage is stepped up, current in
the secondary is less than in the primary. Alkaloid salts are not very soluble in the organic solvent diethyl ether. Likewise if both voltage and resistance are halved. The average time of totality at any location is about 2 or 3 minutes, with a maximum no longer than 7.5 minutes. We know that speed v = distance/time. From Ohm's law, we can see that
this current depends on the voltage that is applied and also on the electrical resistance of the human body. More than one person has had boiling water blast into his or her face. The Sun's differential spin wraps and distorts the solar magnetic field, which bursts out to form the sunspots mentioned earlier. In other words, an electron cannot have just
any amount of potential energy. (a) The bending of light occurs only in outer space. FIGURE 5.36 Water speeds up when it flows into the narrower pipe. To account for Earth's high average density, the density of the core must be at least 10 g/cm 3. When was most of the helium in the universe created? Why isn't dark energy called the dark force? If
the surface is so smooth that the distances between successive elevations on the surface are less than about one-eighth the wavelength of the light, there is very little diffuse reflection, and the surface is said to be polished. Impulse CHAPTER 3 MOMENTUM AN D ENERGY 67 CHECKPOINT 1. This small amount of carbon-13 raises the average mass
of carbon from 12.000 amu to the slightly greater value of 12.011 amu. (This question can also be answered by first performing some algebraic manipulation. Why are clouds that form over land? Interestingly, the oscillations within the Keeling curve reflect seasonal changes in
CO2 levels. Communication satellites have tangential velocities that ensure they fall around Earth. No, but, relative to the stars, the Moon in fact does spin, although quite slowly—about once every 27 days. Its highest peaks emerge above the water in several places, creating oceanic islands such as Iceland. Efficiency can be expressed by the ratio
useful energy output total energy input Even a lever converts a small fraction of input energy into heat when it rotates about its fulcrum. another ball straight down with the same initial speed. (c) attracted to ordinary matter. How does Bernoulli's principle contribute to the increased height? A new member of your discussion group says that, since
Earth's gravity is so much stronger than the Moon's gravity, rocks on the Moon could be dropped to Earth. Dissolved metal ions are attracted to the negatively charged object, where they pick up electrons and are deposited as metal atoms. Why does a solution of a strong acid conduct electricity better than a solution of a weak acid having the same
Science Has Limitations Science, Art, and Religion Technology—The Practical Use of Science is the product of human curiosity about how the world works—an organized body of knowledge that describes the order within nature and the causes of that
order. 766 PARTFOURASTRONOMYTHINKANDRANK(ANALYSIS) 40. How many square meters are illuminated if the wall is 3 m from the light source? G = 6.67 * 10-11 N # m2/kg2 Interestingly, Newton could calculate the product of G and Earth's mass, but not either one alone. How is the fact that these metals have similar
properties reflected in the periodic table? It is also relatively inert, which is why many corrosive chemicals are shipped or stored in Teflon containers. After a period of time, the sludge is removed from the bottom of the settling basin and is often sent directly to a landfill as solid wastes. A useful analogy is a group of ants on a balloon that is expanding
the card to the spool. Transparent plastic cups are made of polystyrene, as are thousands of other household items. What is a temperature inversion? You'll see it best by not looking at it directly. \leq Oxygen Water \leq Methane \geq \geq \geq Carbon dioxide \leq \geq \geq O (a) Reactant oxygen atoms share electrons equally in O2 molecules. Does the tree
lose or gain weight as it respires? The wavelength of radiation is related to the frequency of vibration. (See Activity 33 at the end of this chapter, where you are asked to turn cans upside down and note how many days go by for the poles to reverse themselves.) 9.3 Magnetic Domains EXPLAIN THIS In what ways can magnets lose their strength over
time? Use 9.8 N/kg for g.) (b) Why is the answer the same for an iron ball of any mass? FIGURE 11.1 4 Set the distance between the camera and your image. Should food be irradiated in order to put an end to food poisoning, which kills more than 5000 Americans each year? This was a supernova (a "super new star"), its
glowing plasma remnants now making up the spectacular Crab Nebula, shown in Figure 27.15. Rank these quantities from greatest to least at each point: (a) momentum, (b) KE, and (c) PE. Polarized light would be represented by a single vector. But if the solar system is billions of years old, shouldn't they be depleted by now? In this reaction, the
silver loses electrons to the sulfur. If the water were confined—that is, not open to the atmosphere—the crocs would receive every bit of the pressure you exert. He will have to push with 50 times the weight of the pressure you exert. He will have to push with 50 times the weight of the pressure you exert. He will have to push with 50 times the weight of the pressure you exert.
matter that what you add also dissolves. The condensation produces the vast amounts of rain that are typical of such storms. You release a ball while standing against the floor of an accelerating spaceship. SAM PLE PROBLEM 4 The diameter of the Sun is 1,390,000 km. We can answer this question only if we agree on what we mean by weight. SAM
PLE PROBLEM The Red Sea is presently a narrow body of water located over a divergent plate boundary. Can a full Moon be seen at noon? 9 70°F 65°F 60°F 64°F Convection currents produced by unequal heating of land and water. 15 cm/4 cm = 3.75, so three crates can be carried without sinking. No known forces, however, can stop the continued
contraction, and the star quickly shrinks in size until finally it is crushed, presumably to the size of a microbe, and finally to a realm of size smaller than ever measured by humans. This concentration of water in a narrower zone produces taller, steeper waves. In the early 1800s, the only current-producing devices were
voltaic cells, which produced small currents by dissolving metals in acids. Symbol for sugar molecule, which is sucrose, C12H22O11 Sugar Sugar in water C H A P T E R 16 MIX TURES 399 FIGURE 16.5 (a) (b) detail in Section 16.6. After all the water has been distilled from seawater, dry solids remain. (b) spiral. 156 PA R T O N E P H Y S I CS
LEARNING OBJECTIVE Relate the open structure of ice to water's maximum density at 4°C. What is the difference between rainfall that accompanies the passage of a warm front and rainfall that accompanies the passage of a cold front? When every student scores 80%, the class average is 80%. 112. The monkey, however, sees the dart leave the gur
the mantle operate in symmetrical loops. Although they may both see a rainbow, they are looking at different rainbows. Natural motion had to do with the nature of bodies. At the security area of an airport you walk through a metal detector, which consists of a weak ac magnetic field inside a large coil of wire. 8.8 Ohm's Law EXPLAIN THIS What is
the source of electrons in a body undergoing electric shock? LEARNING OBJECTIVE Distinguish between the reflection and refraction of waves. Cut a narrow slit through a piece of thick paper (or thin cardboard) and place it over a bright fluorescent bulb. Every chapter concludes with a Readiness Assurance Test, a bank of 10 multiple-choice
when (a) both are filled to the brim with water. (Incidentally, this explains why deuterium is such a rare isotope today.) Continued cooling would prevent the further fusion of helium into heavier elements, such as carbon. When rock forms, magnetic minerals in the rock align with the magnetic field. (e) The sample is unchanged. Yet millions of
therapeutic magnets are sold in stores and catalogs. If you turn on the lamp, the line current increases to 20 amperes. The one with the suction cup. (Use the distance = speed * time and data from Table 26.1.) Solution: d = vt S t = d v Convert all
units to metric. What might the spectrum of an atom look like if the atom's electrons were not restricted to particular energy levels? How much larger is this wavelength compared to the size of an atom, which is about 10-10 m? CHECKPOINT One of the beauties of physics is that there are usually different ways to view and explain a given
phenomenon. When the piston is lifted, the intake valve opens and air moves in to fill the empty space. Series circuit An electric circuit with devices connected in such a way that the current is the same in each device. Furthermore, solar wind is capable of stripping a planet of its atmosphere. When you thrust a bar magnet to and fro into a coil of wire
you induce (a) direct current. EXPLAIN THIS VIDEO: Atoms and Isotopes he periodic table is a listing of all the known elements with their atomic masses, atomic numbers, and atomic symbols. Erosion is the process by which weathered rock particles are removed and transported away by water, wind, or ice. You step on the brakes and slow the car to
half speed. (b) Reflected light Incident light Refracted light Incident light Refracted light Transmitted light (c) F I G U R E 11. 2.3 Forces and Interactions EXPLAIN THIS When you push, what pushes back? With a supermassive supergiant, however, the gravitational forces are strong enough to overcome this resistance. The third is the Big Bang's ability to explain the observed
proportions of elements. From Earth people would look up and see a dark new Moon. If you're in a hurry and don't mind the chill, dry yourself off in the dry winter? Atoms, however, can be a source of light, which is what we observe
as we look at an element's atomic spectrum. If the weight of the submerged object is greater than the buoyant force, the object sinks. Now you know why tarred roofs are often covered with gravel. This galaxy consists of two "clouds," called the Large Magellanic Cloud (LMC) and the Small Magellanic Cloud (SMC), both of which are slowly being
pulled into the Milky Way. The boats draw together and collide. Scientific notation is discussed in the Lab Manual for this book. The structural isomer with the greatest amount of branching in the carbon framework likely has the highest octane rating, making neopentane the clear winner. 47. Hewitt 600: Stephen Rudolph/ Shutterstock 604: Michael Manual for this book. The structural isomer with the greatest amount of branching in the carbon framework likely has the highest octane rating, making neopentane the clear winner.
P. Figure 13.11 suggests a comparison of the strengths of these two forces over distance. Natural frequency at which an elastic object naturally tends to vibrate, so that minimum energy is required to produce a forced vibration or to continue vibration or to continue vibration at that frequency. Penzias and Wilson were puzzled. That would be to exactly the
level that would be reached by pouring in a volume of water equal to the volume of the submerged object. H H N CH3 H O H 3C N ≤ H3PO4 N O CH3 N H2PO4 ≥ N CH3 Caffeine, free-base form (water-insoluble) Phosphoric acid caffeine acid caffeine, free-base form but rather as
the salts of naturally occurring acids known as tannins, a group of phenol-based organic acids that have complex structures. It reacts with oxygen, O2, to form carbon dioxide and water. In sunlight, it is white. To understand how light penetrates a transparent material, visualize the electrons in an atom as if they were connected to the atomic nucleus
by springs (Figure 11.5).** An incident light wave sets the electrons into vibration. Some rocks are aggregates of fossil shell fragments, solid organic matter, or any combination of these components. An iron handle of the same temperature would surely burn your hand. Rather, space is in the universe and this space is rapidly expanding. R E A D I N G
C H E C K Q U E S T I O N S (COMPREHENSION) 18.1 Acids Donate Protons; Bases Accept Them 1. Many minerals are easily recognized by their crystal form. From your answer to the preceding problem, would it be possible for two galaxies with stars evenly distributed to pass right through each other? Why is the Moon described as a "silent
planet"? The attached generator converts most of this mechanical energy to electric energy. Recall the classification of air mass is approaching, we can expect cold, moist weather. People may fear loss of this mechanical energy to electric energy.
control more than anything else. A common polymer used to make chewing gum is polyvinyl acetate, with a Tg of about 28°C, which is below body temperature but above room temperature but above room temperature. The factors that influence bond strength are ionic charge, atom or ion size, and packing (Chapter 15). They are so far away, however, that this motion is not
apparent on the time scale of a human life. O O OH Phenol 4-Hexylresorcinol Thymol Methyl salicylate 500 PA R T T W O CH E M I S T RY CHECKPOINT Why are alcohols less acidic than phenols? Early in human history, people discovered that ashes mixed with water produce a slippery solution useful for removing grease. Survey data show that the
immediate feedback and tutorial assistance in MasteringPhysics motivate students to do more homework. Mechanical deformation occurs when a rock is subjected to physical stress. So the helium that pops out of a balloon is better described as an indirect remnant of the Big Bang. A boxer being hit with a punch contrives to extend time for best
results, whereas a karate expert delivers a force in a short time for best results. But, unlike a galvanometer, the current is reversed during each half revolution by means of stationary contacts on the shaft. 250 PARTONE 10.25 Ken Ford tows gliders in quiet comfort when he wears his noisecanceling earphones. Is the force
lower-density solid to a higher-density solid. The search for a deeper understanding of the world around us has taken different forms, including science, art, and religion. The behavior of falling objects was never really understanding of the world around us has taken different forms, including science, art, and religion. The search for a deeper understanding of the world around us has taken different forms, including science, art, and religion. The search for a deeper understanding of the world around us has taken different forms, including science, art, and religion.
known as dark matter, is likely to be "exotic" matter—very different from the elements that make up the periodic table (see Section 28.4). 286 PARTONEPHYSICSFIGURE 11. For comparison, the diameter of our Milky Way galaxy is about 100,000 light-years. A significant role of glass in a florist greenhouse is to prevent convection of cooler
the greatest ability to transport sediment particles and can carry the largest loads. Distinguish between an atom and an element. Gamma ray High-frequency electromagnetic radiation emitted by radioactive nuclei. If you simultaneously drop a pair of tennis balls from the top of a building, they strike the ground at the same time. Although this is very
fast, it nevertheless takes light appreciable time to travel large distances. Most mothballs sold today, however, are made of the less toxic 1,4-dichlorobenzene. A spot in the center of the retina, called the main sequence. The fact that we can't hear the bell indicates that sound does not
nearly as destructive as either starting material. (b) To an inside observer, the light also bends as if responding to a gravitational field. g B g B 9.8 m/s2 57. (Orbital speed about Jupiter is about 5 times that no atoms are lost or gained during any reaction
See Bond(s) molecular, 385-390 Automobiles. Raindrops form when the condensation rate exceeds the evaporation rate. Thus, 16 g of methane, CH4, reacting with oxygen, O2, would yield 36 g of water, H2O. So the air resistance on the jet is 100,000 N. The rod is then negatively charged. Listerine brand mouthwash (named after Joseph Lister)
contains the antiseptic phenols thymol and methyl salicylate. You see greater detail here than at any other part of your retina. A scale in a science lab is likely calibrated to read the same force as 9 N. Interestingly, both groups reported significant relief from pain. Which of the two will encounter more air resistance? It looks like the manufacturer
knows some physics and has a sense of humor. How does the gravitational attraction of Earth to the apple compare? (c) Because gasoline is so strongly attracted to itself, the salt, NaCl, is excluded. Explain how weight can be caused by both gravity and acceleration. Light fur on other parts of the body reflects light of all frequencies and therefore
appears white. Why is ac required? We know pressure acts upward when we try to push a beach ball beneath the water's surface. Chinooks—which are warm, dry winds—occur when high-altitude air descends and is adiabatically warmed. When it hits the ground? LEARNING OBJECTIVE Distinguish between silicate and nonsilicate minerals. How is it
possible for a jet airplane carrying 110 tons of jet fuel to emit 340 tons of carbon dioxide? CHAPTER 3 Matter is stuff that we can see, smell, and feel. Most of the electric energy in a lamp filament is transformed into heat. Identify the force that propels a rocket into space. Then, starting in the 1990s, astronomers began discovering many more Kuiper
belt objects, some as large as or larger than Pluto. The nuclear power industry faces this obstacle because it requires purified samples of two of the most publicized actinides: uranium, Pu. Actinides heavier than uranium are not found in nature but are synthesized in the laboratory. All the bulbs in the three circuits are identical. The
bug overtakes and outruns the waves it produces. The tiniest droplets scatter green light, slightly larger ones scatter green light, and still larger ones scatter green light, and still larger ones scatter green light, and still larger ones scatter green light. Intensity decreases with distance according to the inversesquare law.
electrons. What was the precise temperature at the bottom of Lake Michigan on New Year's Eve in 1901? Hold a spoon in a stream of water as shown and feel the effect of the differences in pressure. Then the rubber band snaps back (and usually stings your fingers!). Hewitt 229: Paul G. Figure 15.10 illustrates the formation of aluminum oxides
mixture is a combination of two or more substances in which each substance retains its own chemical properties. Displacement differs from distance. When magma rises toward Earth's surface, it makes contact with the surrounding rock. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S
(KNOWLEDGE) Boiling A rapid state of evaporation that takes place within the liquid as well as at its surface. The third week? Carbon-14. Thermal energy never flows unassisted from a lowtemperature substance into a higher-temperature one. When both foci are together, the ellipse is a circle. A special thank-you to Leslie's husband, Bob Abrams, for
his assistance with the Earth science material. Professional drivers are familiar with another way to slow a vehicle—shift to low gear to allow the engine to do the braking. Instead, carbon nuclei in its core fuse and liberate energy while synthesizing heavier elements, such as neon and magnesium. The water that exits the unit is now free of calcium
and magnesium ions, but contains sodium ions in their place. 76. Nonfoliated rocks do not have the aligned, platy mineral configuration. What net force of 65 N and friction between the desk and the floor is 60 N? Some 14 billion years ago, a tiny patch of primordial material inflated to form our
gravity. With their polarization axes aligned, a pair of filters transmit all the components of light along the axes. (It increases but eventually tapers off? What is your evidence? What causes this pressure? 318 PA R T T W O CH E M I S T RY E X E R C I S E S (SYNTHESIS) 39. If
so, which way does it tip? Two assertions of Aristotle held sway for some 2000 years. This phase behaves like a gaseous liquid, which is attained by adding lots of pressure and heat. Usually, the wave tracks eastward with the westerlies. Stars shine brilliantly for millions or billions of years because of the nuclear fusion reactions that occur in their
cores. What is the difference between a meteor and a meteorite? These minerals may be produced by organisms, but they are not made of the living organism. Consider your desk at rest on a your bedroom floor. So in this case, the action and reaction forces don't cancel. I'll know why the balls behave so predictably after I learn the rules of mechanics
in the following chapters. If a good absorber were not also a good emitter, there would be a net absorption of radiant energy and the temperature of the absorber would remain higher than the temperature of the surroundings. Over time, this supernova wind of heavy elements spreads to far reaches of the galaxy where the elements are taken in by
nebulae destined to become new stars. Deuterium nuclei would have then fused to form helium. In many countries (the Caribbean, North Africa, and the Middle East), desalinized water makes up most of the municipal water supply. Slow-moving molecules may collide with insufficient force to break their bonds. What are two types of observed motions
that is, without the assistance of external work—the direction of flow is always from hot to cold. Heat of fusion: Q g mLf 42. F F I G U R E B .1 4 B A F F * You can do a simple exercise to see that this is so. So every atom present before the reaction must be present after the reaction, even though the groupings of atoms are different. Sandpaper an iron
nail to give it a clean surface, and then rest the nail in the vinegar solution for about 10 minutes. The nail that you pull out is noticeably warm.) 39. Discuss with your friends why Harry took his vacation early. One second after being thrown, the ball's horizontal component of velocity is 10 m/s, and its vertical component is also 10 m/s. When the only
force that acts on a falling object is that due to gravity, when air resistance doesn't affect its motion, we say the object is in free fall. If your finger appears to jump to the relationship: 1 2 mv 2 Law of conservation of energy Energy cannot be created
or destroyed; it may be transformed from one form into another, but the total amount of energy never changes. A park ranger wants to shoot a monkey hanging from a branch of a tree with a tranquilizing dart. (d) diffracted. This illustration, however, shows a hypothetical bird's-eye view of this observable universe fully matured to the present
moment, which, because of cosmic expansion, would place those most distant objects now some 42 billion light-years away. They proposed that as new basalt is extruded at an oceanic ridge, it is magnetized according to the existing magnetic field. No problem. The top string breaks when the breaking point is reached. Over time, and subjected to
increased heat and pressure, peat transforms into lignite—a soft brown coal. Education is learning about what you don't yet know. Like a compass in a magnetic field, it turns into alignment. What horizontal forces act, and what is the net force acting on the car? Putting atoms together one by one is much like trying to arrange peanut butter-coated
Ping-Pong balls: You can't move the ball without it sticking to your fingers. Show that the toy consumes 60 W of power. A B B C C 52. As long as everyone pulls equally, the ring stays put. As with oceanic-oceanic convergence, magma is generated. The heat of a lightning bolt, however, dramatically increases the kinetic energy of these molecules to
more brightly as the escaping oxygen passes over it. A wholly new approach involves designing logic boards in which molecules (not electric circuits) read, process, and write information. Then, action and reaction forces can be stated in the following form: Action: Object A exerts a force on object B. 529 PARTTHREE ARTHS CIENCE
LEARNING OBJECTIVE Summarize the processes of crystallization for a magma and for a water solution. The solutions become chemically saturated as the temperature decreases, causing various minerals to precipitate. Alpha particles are relatively easy to shield because of their relatively large size and their double positive charge (+ 2). How do
chemical sediments produce rock? Defend your answers. (b) an inelastic collision. For example, suppose you have two arrows, one with a pointed tip and one with a suction cup at its tip. A cucumber shrivels to a smaller size when it is left in a solution of salt water. Repeat with the handle of the fork held against a table after striking it, and the sound
is louder. Stir, and then filter the sand. With only one minor exception, his theory gave almost exactly the same results as Newton's law of gravity. A ristotle divided motion into two classes: natural motion and violent motion. Cirrocumulus clouds are the familiar rounded, white puffs. At the top of your jump, your upward speed decreases to zero. What
happens if bulb A is unscrewed? It follows that the magnetic field intensity in this region is increased as the number of loops is increased. "Last to crystallize" means "crystallize" means "crystallizes at the lowest temperature," which means the last crystallizers have the lowest melting and freezing points. Such extraterrestrial life forms may be similar to the bizarre
forms of life recently discovered adjacent to deep thermal vents on Earth's ocean floor. The orange-apple system accelerates. The mass of one oxygen molecule is approximately 32 amu. To see more of your face, should you hold the mirror closer or farther, or would you have to have a larger mirror? Why might some people consider it a blessing in
disguise that fossil fuels are such a limited resource? Thus, pure water that is hot has a slightly lower pH than pure water that is blood pressure measured in the upper arm, at the elevation of your heart? (d) none of these 8. Electrons whiz around the atomic nucleus, forming what can be best described as a cloud that is more dense where
the electrons tend to spend most of their time. But this is like saving a cannon wouldn't recoil unless the cannon ball had air to push against. This is a most incredible feat, Add to this the fact that carbon atoms can also bond with atoms of other elements, and you see the possibility of an endless number of different carbon-based molecules. If you hold
the energy. Air and other gases under normal pressures and temperatures approach ideal gas conditions. Before a blown fuse is replaced, the cause of overloading should be determined and remedied. Air at these high altitudes is very cold, and only a small amount of water vapor is needed for condensation to occur. LEARNING OBJECTIVE Calculations.
the amount of energy released or absorbed by a chemical reaction using the bond energies of reactants and products. The famous 20th-century physicist Richard Feynman (1918-1988) noted: "The laws of science do not limit our ability to manipulate single atoms and molecules." What does? This is a good group a c t i v i t y! 39. In general, a
physical model is used to replicate an object or system of objects on a different scale. The classification scheme is meaningful because it allows us to visualize the depositional environment in which the rock was formed. How about when the train slows while the coin is tossed? This means that the pressure is doubled. These distorted looking galaxies
are called irregular galaxies. In the outer regions of any atom are electrons, which repel the electrons of neighboring atoms. What is the difference between weather and climate? Would an exothermic reaction be more favored or less favored if it were carried out within a superheated chamber? Aside from pathogens, untreated water from wells or
rivers may contain toxic metals that seep into the water supply from natural geologic formations. They are likely captured asteroids. Lower-frequency infrared light causes whole molecules, rather than electrons, to resonate; again, heat is generated and the glass is opaque. Further suppose that, thanks to their technological proficiency, they are able
to migrate to their new habitats without difficulty. So Earth pulls the falling object downward (call it action). The indicator of choice is phenolphthalein, which you might obtain from your instructor. Does a person on a diet more accurately lose mass or lose weight? Sometimes, when sound reflects from the walls, ceiling, and floor of a room, the
surfaces are too reflective and the sound becomes garbled. That said, consider the enormous downside of pseudoscientific practices, 9 10 PROLOGUE THEN ATUREOFS CIENCE NOTE NOTE OF SCIENCE OF SCIENCE AD IN GCHECK OUES TIONS (COMPREHENSION) 17.1 Chemical Equations 1. To count to a billion would take 31.7
years. Each second, the burning Sun's mass (a) increases. N ewton's first law of motion, usually called the law of motion, usually called the law of motion, usually called the same level as your heart, so the blood pressure in your upper arm is at the same level as your heart. Charged objects
in the field of the dome are either attracted or repelled, depending on their sign of charge. (d) The slow reaction must have a low activation energy, while the fast reaction must have a high activation energy. 57 Polarization occurs only for transverse waves. (b) releases energy. It gets the hydrogen ion from the H3O + , which is behaving as an acid.
After phenol donates the hydrogen ion, it becomes a negatively charged phenoxide ion. In modern science, argument by appeal to authority has little value.* Scientists must accept their experimental findings even when they would like them to be different. Which warms faster when heat is applied: iron or silver? Polymer A long organic molecule made
of many repeating units. High temperature causes increased vibration of molecules in the rock, weakening rock strength and enhancing plastic flow. Spiral nebulae were not simply clouds—they were neighboring islands of stars within a vast emptiness that potentially extended forever. We'll now see that, if an object is projected fast enough, it falls
all the way around Earth and becomes an Earth satellite. Fluids released by the wet rock interact with the wedge of mantle rock between the two plates (see Figure 21.23a). By formula, Q = cm@T = (450 J/kg # °C)(10 kg)(100°C) = 450,000 J. 92 PA R T O N E P H Y S I CS CHECKPOINT 1. Because forces are neither tensional nor compressional,
there is no creation or destruction of lithosphere. Tell how Isaac Newton did understand and how the connection explains why heavy and light objects in free fall gain the same speed in the same time. The mixture of materials settles into layers. We can identify the plane of our solar system in the night sky by noting the positions of the planets, which,
from our point of view on Earth, appear in a roughly straight line relative to one another. A shell is just a region of space in which dark energy grows stronger over time and causes all matter to rip apart. Place a Pyrex funnel mouth-down in a saucepan full of water so that the
straight tube of the funnel protrudes above the water. For the past several centuries, soaps have been prepared by treating animal fats with sodium hydroxide, NaOH, also known as caustic lye. Consider the growth of bacteria that grow by division, so that one bacterium * This appendix is drawn from material by University of Colorado physics
professor Albert A. Chemists refer to this atom-binding force as a chemical bond. Glass Ultraviolet Visible Infrared The first person to notice a delay in light travel was the Danish astronomer Ole Roemer, who in 1675 saw the effect of light's finite speed "with his own eyes" in eclipses of one of Jupiter's moons because of the increased distance of Earth
from Jupiter in six-month intervals. G L O S S A RY Generator An electromagnetic field. Equilibrium rule The vector sum of forces acting on a nonaccelerating object equals zero: 

| S = 0. Rather, there is a gradual change from one to the other as the atoms |
that bond are farther apart in the periodic table. The water molecules in the salt water are being Osmosis. 9 Electric Circuits 8. 5 Color 11. The direction of travel for both sound and light is always at right angles to their wavefronts. Thank you, Moon! During the time of the dinosaurs, a day was only about 19 hours. At position A we see F separated
into two components: f, which is tangent to the path of the projectile, and f \( \Delta \), which is perpendicular to the path. When we compare the purity of two samples, the purer one contains fewer impurities. If a cold air mass moves into an area occupied by a nonmoving warm air mass, the contact zone between them is called a cold front; and if warm air
moves into an area occupied by a nonmoving mass of cold air, the zone of contact is called a warm front. What is likely the major constituent of our universe? This was filmed by starting with the train at rest, inches away from the heroine, and then moving backward, gaining speed. Is it also true that the closer a star is to the center of the galaxy, the
faster it orbits? Tile is a better heat conductor than wood, and it more quickly conducts thermal energy from your feet. Pure tones, those having only one frequency, can be produced electronically. CHECKPOINT Gravitational force.
Sugar in water is a solution in the liquid phase. Radio waves have lower frequency radio wave might be considered a low-frequency radio wave might be considered a low-frequency radio wave might be considered a light wave might be considered a low-frequency radio wave.
backyard, the solar system; our neighborhood of stars, the Milky Way galaxy; and our neighborhood of galaxies, the Local Group. The same occurs when the ice cube with the air bubbles melts. Many of us, therefore, are still struggling with scientific ideas of 400 years ago. Adding iron to the ocean to enhance its ability to absorb carbon dioxide may
help to decrease the amount of carbon dioxide in the atmosphere. At transform boundaries, earthquakes range from mild to moderate. In a broader sense, a force is not a thing in itself but is part of an interaction between one thing and another. (d) Neither. The seafloor is constantly being renewed at midocean ridges located above upwelling
convection cells in the mantle. C H A P T E R 11 REVIEW 289 T H I N K A N D S O L V E (M AT H E M AT I C A L A P P L I C AT I O N) 38. This number, in honor of the 18th-century scientist Amedeo Avogadro. Electromagnetic induction The induction of voltage when a magnetic field changes with time. VIDEO:
Applications of Electromagnetic Induction VIDEO: Faraday's Law S S S N N N other voltage source was needed—only the motion of a magnet in a wire loop. On the floor where the light hits, you place a beach ball covered with an atom that tends
to gain them, the result is an electron transfer and the formation of two oppositely charged ions. In the United States, the vibrational rate is 60 Hz. Amide An organic molecule containing a carbonyl group, the carbon of which is bonded to a nitrogen atom. However, if the charged particle moves in a magnetic field, the magnetic character of a charge
in motion becomes evident: The charged particle experiences a deflecting force.* The force is greatest when the particle moves in a direction perpendicular to the hydroxide-ion concentration. If you lived on a planet only half as far from the
Sun as our Earth, how would the light intensity compare with that on Earth? Without an adjacent benzene ring, this negative charge has nowhere to go. When transportation stops, deposition and sedimentation begin. Then the reaction is the wall exerting a force on your hand. When your feet leave the ground, your upward speed immediately
decreases at the steady rate of g, which is 10 m/s2. If a gas at 0°C could be cooled down by 273°C, it 273 would apparently contract 273 volumes and be reduced to zero volume. In 4.5 billion years, half the uranium presently in Earth today will be lead. A large settling basin is used for this process. But studies of the cosmic background radiation
clearly show a nearly uniform temperature. What kind of path would the planets follow if suddenly their attraction to the Sun no longer existed? But if you want to cool your hot hands, you certainly wouldn't put them in boiling water. Associated with every moving charged particle—electrons, protons, or whatever—is a magnetic field. Of these
molecules, which has the greatest supply of hydrogen atoms per molecule? When the can is inverted into the pan of water, the water vapor condenses. 1.8 The Force of Friction 19. Comment on this idea. Beneath the hydrogen ocean lies an inner layer of hydrogen compressed into a liquid metallic state. This famous graph is known as the Keeling
curve, after the scientist Charles Keeling, who initiated this project and first noted the trends. Resilient to heat, these ants can withstand higher temperatures than any other creatures in the desert. Place any object in a container partially filled with water, and the level of the surface rises (Figure 5.10). (b) In smaller atoms, such as those in a fluorine
molecule, electrons cannot bunch to one side as well because the repulsive electric force increases as the electrons bunch to see a difference in boiling or melting points. What is the product of the reaction between
carbon dioxide and water? Once again, the degree of light bending tells us that the mass of the closer cluster far exceeds that which we would expect based solely on the cluster's luminosity. For this activity, you'll need an isolated loudspeaker (bare of its casing) and a sheet of plywood or cardboard—the bigger the better. and the burning of ignited
gasoline. Copper (atomic number 29), silver (atomic number 47), and gold (atomic number 47), are all in the same group in the periodic table (group 11), which suggests they should have similar—though not identical—properties. The smokestacks of power plants, for example, can be modified to capture CO2, which is then liquefied and pumped
kilometers deep into the ground. Perhaps the universe as we know it has not always existed. Megan (as a toddler) illustrates magnetic induction on page 216 and does a mineral scratch test on xiv T H E C O N C E P T UA L P H Y S I C A L S C I E N C E P H O T O A L B U M page 528. Indeed, the universe before inflation was very, very small—at one
point even smaller than the size of subatomic particles. The transition metals include some of the most familiar and important elements—iron, Fe; copper, Cu; nickel, Ni; chromium, Cr; F I G U R E 1 2 .1 4 Ashes and water make a slippery alkaline solution once used to clean hands. Hewitt (a left) Tom Bochsler/Pearson Education/PH College (b, c, d
left) Richard Megna/ Fundamental Photographs, NYC (top left) John Suchocki/ Paul G. 4 Snow patterns on the roof of a house show areas of conduction and insulation. The observer sees the red light from the lower drop. So in a zone of reverse faulting we would find shortening of the crust. (c) Slate, (b) schist,
(a) gneiss. electric force, which results the strong nuclear tron bombardment, had split in in a splitting of the nucleus. Hewitt, John Suchocki, Leslie A. Chemical change The formation of new substance(s) by rearranging the aconcentrated solution of a weak acid, such as the acetic acid in vinegar,
may be just as corrosive as or even more corrosive than a dilute solution of a strong acid, such as hydrogen chloride. Sulfuric acid, H2SO4, loses two protons to form what polyatomic ion? These are also the most common granular minerals in granite. When the collapsing star is the biggest of the big, gravitational forces can be strong enough to
overcome even the resistance of neutrons. A new and insightful feature of this edition is the Think and Rank tasks, which involve analysis and ranking of the magnitudes of various quantities. In the lithium battery, lithium metal is used as the source of electrons rather than zinc. What physics is being violated here? Do heavier hydrocarbons tend to
produce more or less carbon dioxide upon combustion compared to lighter hydrocarbons? Hydrogen sulfide, H2S, is as different from elemental oxygen, O2. A magnetic field can deflect a beam of electrons, but it cannot do work on the electrons to change their speed. LEARNING OBJECTIVE Describe how
generators transfer rather than produce energy. These impulses are oppositely directed, but are they equal in magnitude? These clouds are characteristic of unstable air. Some of these instruments are sensitive enough to indicate a change in elevation as you walk up a flight of stairs.* Reduced air pressures are produced by pumps, which work by
virtue of a gas tending to fill its container. We see no more than half of the celestial sphere at any given time. Rocks are made of ice. (b) fluids. Momentum is a property of moving things. The speed is in excess of that needed for circular orbit at this distance, and it overshoots to repeat the cycle. When electrons are lost, protons outnumber electrons
and the ion has a positive net charge. In this and the following section, we explore that submicroscopic level to show how the rate of a reaction can be changed, either by changing the concentration or the temperature of the reactants or by adding what is known as a catalyst. velocity? FIGURE 10.37 The shock wave actually consists of two cones—a
high-pressure cone with its apex at the bow and a low-pressure cone with its apex at the bow and a low-pressure cone with its apex at the same time. At the ambient temperatures of our atmosphere, however, these molecules do not
generally have sufficient kinetic energy for the formation of nitrogen monoxide. How are frequency as before, an observer at B would see the waves coming more often. Recall from Section 18.3 that an increase in hydroxide-ion concentration causes the pH
of the solution to rise. If it ever is, scientists will rejoice at the breakthrough. Heat is measured in joules (or calories). So water at 80°C will melt an equal mass of ice at 0°C. 536 PARTHREEEARTHSCIENCEThe flow behavior of magma is influenced by two factors: silica content and temperature. About 60 million years before the end, stars
within galaxies will fly off in every direction. The first is that the ball's horizontal component of velocity doesn't change as the falling ball moves forward. The abundance of dark energy then fits the bill for making up the remaining 73% of the composition of the observable universe, as shown in Figure 28.21. Because grime contains many nonpolar
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components, it is difficult to remove from hands or clothing with water alone. In this way, water performs a double duty. The carat is the common unit used to describe the mass of a gem. These conditions are caused by the delivery of 8.9 excessive power for too long a time in critical regions of the body. From F = G 2, d if d is made 10 times smaller, 1/d 2 is made 100 times larger, which means the force is 100 times greater. (a) The corrosive properties are doubled because the acid and base no longer exist. Answers to RAT 1. (c) The corrosive properties are doubled because the acid and base are combined in the salt. How might you best persuade politicians to take action? A negative ion has a

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net negative charge because it has gained one or more extra electrons. With no component of force parallel to its motion, no work is done and the satellite's KE remains constant. Why is chemistry often called the central science? Mixing Colored Pigments Every artist knows that if you mix red, green, and blue paint, the result is not white but a muddy
dark brown. A powerful engine can produce greater acceleration. CH4 + 2 O2 h CO2 + 2 H2O So if you were given 16 g of methane, CH4, how many grams of water, H2O, would form? What is the origin of most of the natural radiation we encounter? The global combustion of coal annually releases about 13,000 tons of radioactive thorium and
uranium into the atmosphere. Oxygen can form two covalent bonds. Why must an air mass rise in order to produce precipitation? As the less dense rock rises, it takes the place of the sinking dense rock pulled downward by gravity: convection! 21. The two oppositely charged ions are attracted to each other by the electric force, which holds them close
together. Aristotle believed that light things rose like smoke and heavy things fell like boulders. At 40°C, for example, the hydronium- and hydroxide-ion concentrations of pure water are both 1.71 * 10-7 moles/L (the square root of Kw). O ON HO The synthetic-polymers industry has grown remarkably over the past half century. Every neutral
(uncharged) substance has its own appropriate level of electric fluid. The top zone of the upper mantle, and the entire crust, together form the rigid lithosphere. Imitation vanilla flavoring is less expensive because it is merely a solution of the compound vanillin, which is economically synthesized from waste chemicals from the wood-pulp industry.
Midlatitude cyclone A west-to-east-traveling storm with a central low-pressure area about which counterclockwise flow develops (in the Northern Hemisphere) and from which usually extends a cold front and a warm front; generally forms at the polar front. Metals are opaque to visible light. How does the galvanometer respond when the switch in the
first circuit 236 PARTONEPHYSICAL CHANGE PHYSICAL CHANGE PHYSI
The chemical properties of substances allow them to transform to new substances. For the most part, metals found in nature are chemical compounds. Discuss your explanation with no understanding of science to suspect that the continents were once connected? We can
express this in exact quantitative terms with a few calculations. Name three galactic clusters found in our Local Supercluster. The large area presented by the open chute results in a lower terminal speed, slow enough for a safe landing. Explain how radioactive decay has always warmed the Earth from the inside and how nuclear fusion has always
warmed the Earth from the outside. In the United States, natural sources of fresh water are relatively plentiful, allowing companies to sell fresh water at rates of a fraction of a penny per liter. They are radioactive, most with very short half-lives, but some with half-lives of thousands of years. This unit was named after Georg Simon Ohm, a German
physicist who, in 1826, discovered a simple and very important relationship among voltage, current, and resistance. FYI 404 PA R T T W O CH E M I S T RY 1 liter Sugar solution Concentration: 1 mole per liter 1 mole of sucrose equals 6.02 1023 molecules of sucrose F I G U R E 1 6 .1 4 An aqueous solution of sucrose
that has a concentration of 1 mole of sucrose per liter of solution contains 6.02 * 1023 sucrose molecules (342 g) in every liter of solution. Inhabitants of the International Space Station do not have a (a) force of gravity on their bodies. Try this activity with tap water instead of salt water to see the difference dissolved ions make—the ions are needed to
conduct electricity between the two electrodes. At the macroscopic level, matter is large enough to be seen, measured, and handled. This suggests that the rusting of iron is a chemical change there is no appreciable difference in electric potential between your hands. Work done to raise the ram, giving it potential energy, becomes
kinetic energy when the ram is released. CHAPTER 3 (c) What is the single position of the pendulum where "no work by gravity" occurs? Albert Einstein put it well when he stated, "No number of experiments can prove me right; a single experiment can prove me right; a single experiment can prove me wrong." Consider the biologist Charles Darwin's hypothesis that life forms evolve from
simpler to more complex forms. The edges of these cones are visible in the photograph of the supersonic bullet in Figure 10.36. The irregular galaxy first described by the navigator on Magellan's voyage around the world in 1521 is our nearest neighboring galaxy—the Magellanic Clouds. (a) Lines of force about a single positive charge. Many loops of
wire are wound about an iron cylinder, called an armature, which then rotates when the wire carries current. S-14 O D D - N U M B E R E D S O LU T I O N S Gamma radiation does not affect the atomic number or the atomic mass number. The closest planet, Mercury, would be an apple seed located about 40 m (130 ft) away. A = B = C (all the same).
No. Although benzene and aspirin both contain a benzene ring, these two molecules have different overall structures and quite different chemical properties. What causes window fogging is the humidity in the car caused by rain, by wet clothes, and by the breath of the passengers. These materials are referred to as superconductors. (a) more acidic,
because there are more hydronium ions being added to the solution (b) less acidic, because the concentrated solution of the hydronium ions being added to the solution (d) less acidic, because the
concentration of hydroxide ions will increase 5. With a basic understanding of the concepts of chemistry, however, you already have much insight into their properties. Replacing paved roads with steel rails reduced friction further. Microscopic slush in water tends to make the water (a) more dense. Mercury is pushed up into the tube by atmospheric
pressure. You are really comparing the inertias of the objects. Pitch The subjective impression of the frequency of sound. You cannot avoid radioactivity, for it's in the air you breathe and the foods you eat, and it has been that way since before humans first walked on Earth. A nebula currently visible within the constellation of Orion is shown in Figure
26.2. Within the nebula from which our solar system formed, the gravitational pull on particles exceeded the tendency of gas to disperse and fill all available space. But they are highly refined speculations based on a great deal of collected evidence. How many joules are needed to change the temperature of 1 g of water by 1°C? Two people who weigh
the same climb a flight of stairs. Horizontally? (a) less energy, because of less mass per nucleon (b) less energy, because of less mass per nucleon (c) more energy, because of less mass per nucleon (d) more energy, because of less mass per nucleon (e) more energy, because of less mass per nucleon (fine the same climb a flight of stairs. Horizontally? (a) less energy, because of less mass per nucleon (d) more energy, because of less mass per 
of the downstairs faucet? By swift execution, the time of contact is very brief, which makes the force of impact huge. Stay tuned. The heat warms the surrounding upper-level air, causing it to rise. Yellow daffodils reflect a broad band of frequencies. How many moles of sugar (sucrose) are there in 5 L of sugar water that has a concentration of 0.5 M?
Science The collective findings of humans about nature, and a process of gathering and organizing knowledge about nature. The terms "radio light" are rarely if ever used, likely because the radio part and X-ray part of the spectrum are far removed from the visible part. (c) air still in the balloon. The Joplin tornado, with the highest
intensity rating of EF-5 (winds in excess of 200 mph), is ranked as the 8th deadliest single tornado to strike the United States. Rank the pitches heard, from highest to lowest. When a skydiver steps from a high-flying plane, the air resistance on the skydiver's body builds up as the falling speed increases. G-10 G L O S S A RY Silicate A mineral that
contains both silicon and oxygen and (usually) other elements in its chemical composition; silicates are the largest and most common rock-forming mineral group. Discuss why this is so. What is a native metal? In all, three different structures are shown. Look at open doorways or windows of distant houses in the daytime, and they, too, look black.
which we still abbreviate mv.* We can see from the definition that a moving object can have a large momentum if it has a large mass, a high speed, or both. When a heavy element such as uranium undergoes fission, there aren't fewer nucleons after the reaction. Make a clean-cut pinhole at the other end. This behavior of water is very important in
nature. 2 1 Just beneath the photon sphere, an astronaut can still shine light to the outside. For example, a carbon-12 atom—the nucleus of which is made up of six protons and six neutrons—has a mass of exactly 12.00000 atomic mass units (amu). (The reason for this, as you may recall from Chapter 13, is that the average mass per nucleon is lower
for iron than for any other element.) Once nuclei transform to iron, the fusion process stops. zone P-wave Taken together, the discoveries shadow zone of Oldham, Mohorovic i'c, Guten140° berg, and Jeffreys indicate that Epicenter Earth consists of three layers of P- and SP- and Smaterials of different composition: waves waves the crust, mantle, and
core. FIGURE 8.31 New Zealand physics instructor David Housden constructs a parallel circuit by fastening lamps to extended terminals of a common battery. This is how freeze-dried coffee is produced. The descending air is warm because condensation releases heat. Why is treated water sprayed into the air before it is piped to users? If Earth took
this same amount of time to spin on its axis, what might we note about the Sun's position in the sky? And more collisions means greater air pressure. A dolphin's main diet is fish. 3 4 Energy changes with change of phase. FYI Atmospheric Lifting Mechanisms Clouds are great indicators of mechanisms weather. How are the planets similar, and how
are they different? Piece by piece, it all came together in the 1960s, as a result of seafloor exploration. The yeast in bread dough feeds on sugar to produce carbon dioxide. This attraction is usually sufficient to lift the grime away from the surface being cleaned. For example, glass, though solid, has no crystal structure. Recall from Section 15.3 that an
ionic bond is formed when an atom that tends to lose electrons makes contact with an atom that tends to gain them. As an analogy, consider the wire loop shown in Figure 12.28. It is common to think of a fact as something that is unchanging and absolute. To indicate their importance, we call these electrons valence electrons (as described in Section
15.5), and we call the shell they occupy the valence shell. Because we observe the universe to be rather flat, astronomers puzzled over where this remaining 73% of matter might be. What is the atomic symbol for the element cobalt? Which consists of fragments that never coalesced into planets? Kilogram The unit of mass; one kilogram (symbol kg) is
the mass of 1 liter (L) of water at 4°C. For light elements, it is sufficient to have about as many neutrons as protons. Because wind power can't be turned on and off at will, it is presently a supplement to fossil and nuclear fuels for large-scale power production. Examples are gypsum, anhydrite, and halite. Like an iceberg, the thicker it is, the farther it
extends into the supporting medium. And if the surface is inclined surface is inclined surface is inclined surface, and native elements such as gold and silver. The three pairs of metal, same-
size spheres have different charges on their surfaces as indicated. measures, such as water pumps, that act to keep the reactor core cool in the event of an accident. Consider this event in three systems: (a) An external force acts on the eight-ball system, and its momentum increases. (b) color subtraction. 4 6 Sunlight incident on two raindrops, as
shown, emerges from them as dispersed light. 4 Refraction 11. The corrosive action of an acidic solution is caused by the hydronium ions rather than by the acid that generated those hydronium ions. If we were to slow down, the steepness of the curvature would cause us to fall into the Sun. As a rule, organic compounds—those containing carbon
oxygen, and hydrogen atoms—all together— are not minerals. Of the approximately 300 known pulsars, only a few have been found emitting X-rays or visible light. Scientists use the word theory in a way that differs from its usage in everyday speech. It is usually in the form of a wire coil with a piece of iron inside the coil. Changes in the primary
current produce changes in its magnetic field, which extend to the secondary, and, by electromagnetic induction, voltage is induced in the secondary. 20.6 Rock Types 17. FIGURE 5.22 You don't notice the weight of a bag of water while you're submerged in water. They also conflicted with Church teachings and were banned for 200 years. The
primary is powered by an ac voltage source, and the secondary is connected to some external circuit. The key word in this law is continues: an object continues to do whatever it happens to be doing unless a force is exerted upon it. (c) more than 2 A. CH4 1/2 O2 i CO2 1/2 H2O Was this your answer? A runaway greenhouse effect is thought to have
occurred on Venus, which today has an atmosphere that is 96% carbon dioxide, with an average surface temperature of 460°C. As large as the observable universe is large is as small as the effect on current through a circuit of
steady resistance when the voltage is doubled? Note the four pairs of transverse wave pulses that move toward each other. What is the approximate mass in kilograms of a column of air that has a cross-sectional area of 1 cm2 and extends from sea level to the upper atmosphere? With the calcium and magnesium ions bound to the carbonate ion, as
shown in Figure 16.25, the soap or detergent is free to do its job. So has the "healthy life expectancy," which is a measure of how long people remain in good health. Then over the millions of years during which the solar nebula collapsed, it heated up, spun faster, and flattened into a disk shape. FIGURE 10.20 Two sets of overlapping water waves
produce an interference pattern. Imagine synthetic polymers that mimic photosynthesis by transforming solar energy, or that efficiently separate fresh water from 22°C to 30°C. Ultimately, this is a global issue: Peoples of all
nations should be encouraged not to waste material resources. Other active galaxies are active by virtue of their galactic core, which hosts a black hole more massive than millions or even billions of Suns. Is the negative kid just as negative kid just as negative kid just as negative as one of the positive? Lead, for example, has about one and a half times as many neutrons as
protons. (c) The fast-moving submicroscopic particles of the gaseous phase are separated by large average distances. Einstein abandoned his notion of a cosmological constant, which for the next 75 years remained a historical curiosity. According to a chemist's definition, however, orange juice is any FIGURE 16.8 thing but pure, as it contains a wide
variety of materials, including water, pulp, (a) In heterogeneous mixtures, the flavorings, vitamins, and sugars. Also note the wavefronts drawn at right angles to the ray. People began to accept the idea of molecules because they saw how well it answered questions and explained observations. on the frequency of the sound wave. The total current in
the circuit divides among the parallel branches. Except for this exercise, which probes your powers of analytical thinking, this textbook ignores the slight role that temperature plays in pH. 10 m? If you touch both terminals with a metal wrench, for instance, you can create a spark that can ignite hydrogen gas in the battery and send pieces of battery
and acid flying! FYI because of the initial huge expense in the installation of 110-V equipment. The reason for this acidity is illustrated in Figure 19.12. Skin, muscle, and fat are almost transparent to dolphins, so they acoustic image of what it has "seen," placing the image directly in the minds of other dolphins. (b) Atmospheric pressure decreases
with increasing temperature. Suppose that a 400-kg crate of auto parts is loaded onto the barge. To market the new drug, Bayer invented the name aspirin, in which "a" is used as a common suffix for medications. Assimilation of surrounding rock and
crystallization increase the silica content of the magma, producing andesitic magma and, given enough time, granitic magma and, given enough time, granitic magma and carboxylic acid. Copper statues exposed to the carbon dioxide and
water in the air become coated with patina. Where does this energy go? How many molecules of sucrose is this? We live on a moving Earth. For radioactive atoms, the chance of "dying" (undergoing decay) is always the same, regardless of the age of the atom. If high-silica minerals are the last to crystallize, why aren't high-silica minerals the last to
melt? Such a material is opaque to light. If applicable to humans, hydrogen sulfide-induced suspended animation holds many possibilities, including protection against lethal cellular damage caused by strokes, heart attacks, or other critical injuries in which either blood flow or blood supply is severely limited. An alternative theory to dark matter is
Modified Newtonian Dynamics (MOND), proposed by the physicist Mordehai Milgrom in the early 1980s. Best viewing comes with a good pair of binoculars far away from city lights. The melting process is enhanced by the pressure of automobiles rolling along the salt-covered icy surface, which forces the salt into the ice. Does a gas release energy or
absorb energy when it changes into a liquid? Energy is absorbed when change of phase is in this direction. This voltage change is along each line, not between the lines.) (c) Show that the power expended as heat in both lines together is 1.38 kW (distinct from power delivered to customers). Nor does it recognize the electromagnetic force (see
Chapter 8), which is responsible for light and electric charge. 13.5 Nuclear Fission EXPLAIN THIS Why isn't it possible for a nuclear power plant to explode like a nuclear bomb? FIGURE 20.29 These "jaws" of travertine at Pamukkale in Turkey were created by the precipitation of calcium carbonate, CaCO3, from a hot mineral spring. The equilibrium
rule, \Theta F = 0, applies to (a) objects or systems at rest. Frozen food warms up faster in a warm room than in a cold room. The boiling point of octane, 125°C, is therefore much higher than that of methane, and octane is a liquid at room temperature. A potential of 1 volt (V) equals 1 joule (J) of energy per 1 coulomb (C) of charge: 1 volt = In a nutshell:
Electric potential and potential and potential mean the same thing—electric potential energy per unit charge—in units of volts. More commonly, the Sun's image may reveal sunspots. Over time, while all dark matter stayed distributed throughout the clump, the ordinary matter became concentrated at the center (Figure 28.19). Temperature A measure of the
hotness of substances, related to the average translational kinetic energy per molecule in a substance, measured in degrees Fahrenheit, or kelvins. What is surprising, however, is that studies indicate that the atmospheric concentration of CO2 is not increasing proportionately. More important, notice that the 1-s interval positions
correspond to 10-m/s velocity changes. Black hole The remains of a giant star that has collapsed upon itself. Because water is practically incompressible, its density is very nearly the same at all depths. Rather, its predictions depend on coincidence and
also on the tendency of many people to seek external explanations for their fates or personal behaviors. If the air is unstable, cumulus clouds may form. What is electrolysis, and how does it differ from what goes on inside a battery? When another straw that has also been rubbed with wool is brought nearby, the two straws repel each other. Is this an
oxidation or a reduction? Ampere The unit of electric current; the rate of flow of 1 coulomb of charge per second. Although movement is extremely slow, rock actually flows in convection currents that allow hot materials to rise and cool 
more substances in which each substance retains its chemical properties. Liquid and gas are both fluids because they flow. In circuit 3 both ends of the lamp filament are connected to the same terminal and are therefore at the same potential. Because S-waves cannot travel through liquid, but P-waves can (at a reduced speed), Oldham deduced that
the earthquake waves had encountered an internal boundary—he had discovered Earth's core. We see this occurring when smoke from a fire rises and then settles off as it cools and its density (b) matches that of the surrounding air. Thicker clouds have a higher chance of producing rain because the droplets have more time and space to coalesce into
drops that are heavy enough to fall. (c) Since some of the water evaporated while boiling, the salts in the water are now more concentrated. The energy ordinarily becomes thermal energy. Primary wave (P-wave) A longitudinal body wave that compresses and expands the material through which it moves; it travels through solids, liquids, and gases
and is the fastest seismic wave. Because of the time delay between absorptions and re-emissions, the light travels through empty space. So if the amount of space within the universe? Pressure is defined as the force exerted over a unit of
area, such as a square meter or square foot:* Pressure = force area FIGURE 5.2 CHECKPOINT Does a bathroom scale measure weight, pressure, or both? I must supply energy to these magnets in order to pull them apart. (0.5 kg) vbefore = (0.5 kg + 1.5 kg) vafter vafter = 0.5 kg vbefore 0.5 kg vbefore vbefore = (0.5 kg + 1.5 kg) 2 kg 4 This makes
sense, because four times as much mass will be moving after the collision, so the coupled carts will glide more slowly. The process of compressing outside air to a roasting 55°C (131°F). They don't have the multiple meanings that so often
confuse the discussion of ideas expressed in common language. These silica-rich rocks are partially melted by the rising magma and incorporated into the melt, which increases the magma's silica content. At any instant you can tell the speed of the car by looking at its speedometer. Thus, because 342 g of sucrose contains 6.02 * 1023 molecules of
sucrose, we can use our shorthand wording and say that 342 g of sucrose contains 1 mole of sucrose. Similarly, the logarithm of 1000 is 3 because 10 raised to the third power, 103, equals 1000. The feather's weight is very small, so it reaches terminal speed very quickly. Fine gold pieces hidden in a mixture of mud and sand settle to the bottom of the
pan when the mixture is swirled in water. At convergent boundaries, regional metamorphism involves mechanical deformation and elevated temperatures and pressures. Rather, they experienced slow, bumpy rides in horse-drawn carts. So that the table can fit nicely on a standard paper size, these elements are commonly placed below the main body
of the table, as shown in Figure 12.16. (b) atoms. This includes probability clouds and atomic orbitals, which you would learn about in a follow-up course on chemistry. According to Einstein's equation, this newly acquired energy reveals itself as an increase in the nucleon's mass. 04 The alignment of Earth, the Moon, and the Sun also produces a lunar
eclipse when the Moon passes into the shadow of Earth, as shown in Figure 26.34. Conduction The transfer of thermal energy by molecular and electron collisions within a substance. As the numbers of atoms and bonds increase, a single crystal forms, with edges reflecting the shape of the underlying geometric pattern. The following Checkpoint
illustrates this idea with an analogous rubber band. Speed Before the time of Galileo, when measurements of time were vague, people described moving things as simply "slow" or "fast." Galileo measured speed by comparing the distance covered with the time it takes to move that distance. Force pair The action and reaction pair of forces that occur
in an interaction. What physics principle underlies the following three observations? When it melts, it shrinks back down to its original size, which is why the water level doesn't change. Hint: Use Boyle's law from Chapter 5. A common saying goes, "It's not the fall that hurts you; it's the sudden stop." Translate this into Newton's laws of motion. 380
370 360 350 340 330 320 310 19571960 1970 1980 Year 1990 2000 2010 *ppm = parts per million, which tells us the number of carbon dioxide molecules for every million molecules of air So the pH of the oceans. In the formation of a condensation
polymer, a small molecule (i.e., water or hydrochloric acid) is released from each monomer. Whenever a rotating body contracts, its rotational speed increases. The force of friction on the crate is 80 N. This force component reduces the speed of the satellite. He needed the power of the newly constructed Mt. Wilson telescope, which allowed him to
distinguish individual stars within neighboring galaxies (Figure 28.2). If your momentum is zero, is your kinetic energy necessarily zero also? Why does a nebula spin faster as it contracts? Why is there no atmosphere on the Moon? Further, suppose that one bacterium is put in a bottle at 11:00 A.M. and that growth continues steadily until the bottle
becomes full of bacteria at 12 noon. Configuration A description of how the atoms within a molecule are connected. What particle within an atom vibrates to generate electromagnetic radiation? LEARNING OBJECTIVE Explain the underlying conditions that produce thunderstorms, hurricanes, and tornadoes. This photo shows the exposed rift valley
on Iceland. Also, because of how the metals and nonmetals are organized in the periodic table, positive ions are generally derived from metallic elements. Carbon-14 dating The process of estimating the age of once-living material by measuring the amount of radioactive carbon-14
patches or, with weak rising motion, appear as rounded masses. Which requires more fuel: a rocket going from Earth? And, dear to all three authors, our late friend Charlie Spiegel is shown on page 268. This lost mass has been converted to energy, which is why nuclear fusion is an energy.
releasing process. Between light and an X-ray? Electric potential is not the same thing as electric potential energy. Hewitt 271: (top) Bill Bachman / Alamy 2
sinks. Scanning probe microscope A tool of nanotechnology that detects and characterizes the surface atoms of materials by way of an ultrathin probe tip, which is detected by laser light as it is mechanically dragged over the surface. What is the unit of electrical resistance? This seems like a contradiction, because warm air rises. Because air becomes
less dense with altitude, a lesser weight of air is displaced per given volume as the balloon rises. Neutrons produced in fusion cause more fission in this blanket. When two colors are added together to produce white, they are called complementary colors. It is speculation. The overlapping waves form a V shape, called a bow wave, which appears to be
dragging behind the bug. Because of public phobia about anything "nuclear," this diagnostic technique is now called MRI. Such monopoles, however, have never been detected despite countless attempts to find them. The vibration of a factory floor caused by the running of heavy machinery is another example of forced vibration. Softening Hard
Water Water containing large amounts of calcium and magnesium ions is said to be hard water, and it has many undesirable qualities. For elemental formula for gold, and Li is the elemental formula for lithium, to name just
two examples. But how many grams is 2 moles of water? (b) F I G U R E 1 5 .11 (a) Sodium chloride, as well as other ionic compounds, forms ionic crystals in which every internal ion is surrounded by ions of the opposite charge.
Only the electrons move significantly, sloshing back and forth in alternating fashion with each rotation of the armature. 21 LEARNING OBJECTIVE Describe the rule examples. Perhaps a fish "forgets" about the weight of water in the same way. The thicker the region containing water drops, the thicker the conical edge you look
through and the more vivid the rainbow. The space around the magnet is energized by a magnetic field. Some noisy devices such as jackhammers are now equipped with microphones that send the sound of the device to electronic microchips, which create mirrorimage wave patterns of the sound signals. Several steps lead to the formation of an
occluded front. So, interestingly, the greater volume of displaced air doesn't weigh more, and buoyancy remains the same! If a balloon is not free to expand, buoyancy decreases as a balloon rises because of the less dense displaced air. Neutrons act like "nuclear cement" to hold the nucleus together. Five times as distant? The sailboat is sailing close
to the equator, as evidenced by the perpendicular orientation of the crescent moon. Scientists consider this tendency of energy to disperse Because energy naturally tends to be one of the central reasons for both physical and to disperse Because energy naturally tends to be one of the crescent moon. Scientists consider this tendency of energy to disperse, a reaction that leads chemical changes, than a point nearer the center. F I G U R E 2 1 .1 7 Oceanic trench Ocean
New oceanic crust Lithosphere Midocean ridge Oceanic trench The Mid-Atlantic Ridge runs down the center of the Atlantic Ocean. At temperatures below 100 billion K, there is insufficient energy to allow this transformation. You're having a run of bad luck, and you slip quietly into a small, calm pool as hungry crocodiles lurking at the bottom are
relying on Pascal's principle to help them to detect a tender morsel. In the second pot, use boiled water that has cooled down to the same temperature. Because water cannot soak into the ground, storm water runoff increases. Across any period, the properties of elements gradually change. (c) A rock is crushed to powder. In general, these metal
atoms tend to form positive ions, but the number of electrons lost varies. 15.2 The Formation of Ions 4. Trim away excess plastic wrap. Would the class average be slightly lower, the same, or slightly higher if one of the students instead scored 100%? If we ignore the rules for significant figures (see Appendix B) and assume that the 20.0 g of sodium
chloride occupies 7.50 mL (0.00750 L), this volume of solution - Volume of solution - Volume of solution - Volume of solution and reason, people could uncover the workings of the physical universe. With the proper tangential
velocity, it falls around Earth, rather than into it, and becomes an Earth satellite. If you break a bar magnet in half, each half still behaves as a complete magnet in half, each half still behaves as a complete magnet. So when a kilometer of mountain erodes away, some 85% of a kilometer of mountain returns. The best result for the boxer is reduced force, accomplished by maximizing time, and the best
result for the karate expert is increased force delivered in minimum time. The incident and reflected rays lie in a plane that is normal to the reflecting surface. Only when all the water in the tub freezes will the temperature of the cellar go below 0°C and then freeze the canned goods. Rank from greatest to least the (a) masses of the 100-kg box of
tools and (b) weights of the 100-kg box of tools. Waste products were dumped into rivers, buried in the ground, or vented into the air without regard for possible long-term consequences. Recall from the beginning of this chapter that astronomers estimate that there are about 100 billion stars in our galaxy and about 100 billion galaxies in our
observable universe. So no, you cannot lift it without the use of some type of machine. It states that for two charged objects that are much smaller than the distance between them, the force between them varies directly as the square of the separation distance. What was Einstein's cosmological constant? F
= G 4.5 Projectile Motion Why do a dropped ball and a ball thrown horizontally hit the ground in the same time? In the beginning, anything seemed possible. What differentiates Jupiter from a star? A speeding baseball may possess the capability of exerting a force on another object when interaction occurs, but it does not possess force as a thing in
itself. It is a sideways force—perpendicular to the wire. As long as the attractive strong nuclear force is stronger than the repulsive electric force, the protons remain together. They march to the delayed beat they hear. What is Lucy's weight? Discuss the advisability of this loose coupling and slack between cars from the point of view of impulse and
momentum. What happens to the gas pressure within a sealed gallon can when it is heated? Recharging a rechargeable battery requires the input of electrical energy; hence, the reactions that occur during the recharging process are endothermic. The difference is a net force that does work to give the box its kinetic energy. A 5-gal pail of water
(density of water = 1.0 g/cm3) has a mass of about 18 kg. Fnet 160 N - 80 N 80 N 41. If you push to the right on a heavy piece of furniture? One of the products of combustion is water vapor. The principal difference is the time taken to finally extinguish the supply. (c) How does the time of
ascent compare with the time of descent? be infinitely soluble in that solvent. Above temperatures of 374°C and pressures of 218 atm, water transforms into a state of matter known as a supercritical fluid, which resembles both a liquid and a gas. "Satellites remain in orbit instead of falling to Earth because they are beyond the main pull of Earth's
gravity." Was this your answer? 134 PA R T O N E P H Y S I CS If a balloon is free to expand FYI when rising, it gets larger. Cinder cones are not restricted to a particular type of lava. Thin films of PET, which are called Mylar, can be coated with metal particles to make magnetic recording tape or those metallic-looking balloons for sale at most
grocery store checkout counters. 300,000 km/s = 2.42 124,000 km/s 
planets different from the inner planets aside from their location? F I G U R E 3 .1 9 He raises a block of ice by lifting it vertically. They also levitate and propel high-speed trains. FIGURE 18.20 Oxidation results in a greater positive charge, which can be achieved by losing electrons, gaining oxygen atoms, or losing hydrogen atoms. The ice and water
are in thermal equilibrium. Chemical formula A notation that indicates the compound, consisting of the atomic symbols for the definition of a compound and numerical subscripts indicating the ratio in which the atomic symbols for the definition of a compound and numerical subscripts indicating the ratio in which the atomic symbols for the definition of a compound and numerical subscripts indicating the ratio in which the atomic symbols for the definition of a compound and numerical subscripts indicating the ratio in which the atomic symbols for the definition of a compound and numerical subscripts indicates the compound and numerical subscripts indicating the ratio in which the atomic symbols for the definition of a compound and numerical subscripts indicating the ratio in which the atomic symbols for the atomic symb
An atom loses an electron to another atom. Both are equal when the monkey hangs in equilibrium. However, if the same current might be large enough to burn your flesh. Original horizontality Layers of sediment are deposited evenly, with
each new layer laid down nearly horizontally over the older sediment. And then came the explanation of Einstein, whose general-relativity equations, when applied to Mercury's orbit, predict the extra 43 seconds of arc per century! As a second test of his theory, Einstein predicted that measurements of starlight passing close to the Sun would be
slightly deflected but large enough to be measured. Does the fact that compass needles point to Earth's poles tell us that Earth is a giant magnet? Stars that are about as massive as the Sun, and those that are less massive, evolve to become white dwarfs; stars with masses of 10MSun or greater evolve to become neutron stars; the most massive stars
of about 40MSun or greater ultimately become black holes. Imagine a 40,000-km steel pipe that forms a ring to fit snugly entirely around the circumference of Earth. Red light has a higher frequency than a photon of infrared light. In this way, sound compressions (or rarefactions)
from the hammer are canceled by mirror-image rarefactions C H A P T E R 10 WAV E S A N D S O U N D 249 The superposition of two identical transverse waves in phase produces a wave of increased ampitude. (b) The polyethylene strands of LDPE are branched, which prevents the strands from packing well. If an immersed body displaces 1 kg of
fluid, the buoyant force acting on it is equal to the weight of 1 kg.* By immersed, we mean either completely or partially submerged. ester 4. FIGURE 16.26 (1) Negatively charged sites on the unused ion-exchange resin are occupied by sodium ions. Then discuss how the average speeds of H2O molecules compare with those of N2 and O2 molecules
"Caution: This product contains tiny, electrically charged particles moving at speeds in excess of 100,000,000 kilometers per hour." 115. Neutrons escape surface Neutrons trigger more reactions FIGURE 13.24 The exaggerated view shows that a chain reaction in a small piece of pure U-235 runs its course before it can cause a large explosion
because neutrons leak from the surface too soon. You can quickly sense this difference when you step outside. Why does he still feel cold? 299 Most water molecules, H2O, consist of hydrogen atoms with no neutrons. Also, as ordinary matter congregated toward the center, the rate of rotation would increase—angular momentum would have been
conserved. (b) increased surface area. This force can be broken up into two components, one sideways and the other up. A supernova is such an energetic release of energy that it is an endall event occurring never more than once for a particular supergiant star. To help his attack ship maneuver near shore during beach landings, Hess used a
fathometer, an innovative depth sounder, to map the underwater topography. List the following atoms in order of increasing atomic size: thallium, Tl; germanium, Ge; tin, Sn; phosphorus, P. If the wave doesn't die out, warm air continues to move poleward as cold air pushes toward the equator. A E C 8 m/s 10 m/s 4 m/s C B 73. The additional pressure
is exerted against every square centimeter of the larger piston. Likewise if they are closer together. Recall that sodium chloride is not a mixture of sodium and chlorine atoms but is instead a compound, which means it is entirely different from the elements that it contains. VIDEO: Definition of Momentum 3.1 Momentum and Impulse Why do
cannonballs shot from long-barreled cannons experience a greater impulse for the same average force? The speed at which seismic waves travel and the paths that they take provide scientists a view into Earth's interior. Water flows through the pipe if there is a difference in pressure across (or between) its ends. In accepting the hydrogen ion
H2PO4- is behaving as a base. Glacier A large mass of ice formed by the compaction and recrystallization of snow, moving downslope under its own weight. With Albert Einstein's consent, Szilard drafted a letter that was signed by Einstein and delivered to President Roosevelt in 1939. Through cosmology we attempt to answer such questions as How
did the universe come into being? The silicates are the largest mineral group because silicon and oxygen are (a) the hardest elements on Earth's surface. The distribution of matter and energy in the post-inflation era would not have been perfectly uniform. What is the buoyant force on the container? It is your weight. (c) Mercury. Which exerts more
gravitational force on the baby: Mars or the obstetrician? If you want really empty space, you'll need to travel to the vast voids that separate the superclusters as was shown in Figure 27.36. Wavelength (b) A longitudinal wave is one in which the direction of wave travel is along the direction in which the source vibrates. These mobile electrons move
quickly and transfer energy to other electrons, which migrate quickly throughout the solid. We say the diver has reached terminal speed. Relative to this force, does the electron attract the proton with less force, more force, or the same amount of force? Weather changes can occur slowly or very quickly. The KE of a pendulum bob is maximum where
it moves fastest, at the lowest point; the PE is maximum at the uppermost points. 10.6 Forced Vibrations and Resonance 16. In this and all such equations, the mass numbers at the bottom also balance (92 = 90 + 2). (b) Ohm's law. All the elements lighter than iron are formed through the
more common stellar process of exothermic thermonuclear fusion. One thing is for sure: the universe holds no shortage of mysteries. It's only from these regions that dark energy appears to be taking hold. But melting does not occur this way—partial melting is the rule. It remains a gas and is collected at the top of the tower. Mass is a measure of
inertia. This process is repeated all the way to the goal.* The mind that encompasses the universe is as marvelous as the universe that encompasses the mind. Consequently, these electrons are easily dislodged, leaving behind posRelate the properties of a metal itively charged metal ions. The layers—the crust, mantle, and core—differ in composition
and density. For this project, find the weight of your car from the Internet, and then divide it by 4 to get the approximate weight held up by one tire. LEARNING OBJECTIVE Distinguish between force and net force, and give examples its
weight. KE is zero after the collision, but it was greater than zero before the collision. Helium was produced in the few minutes after the Big Bang. (Hint: Think of the satellite's orbit as a ring around Earth.) 115. Ohm discovered that the amount of current in a circuit is directly proportional to the voltage established across the circuit and is inversely
proportional to the resistance of the circuit: Current = Some materials, such as germanium or silicon, can be made to alternate between having an excess or a deficiency of electrons by adding impurities to them. In sport balloons, the gas is simply heated air. Aha, but launching speeds are not equal for heavy projectiles thrown at different angles. We
speak of climate change. The eastward-moving effect of revolution, however, is enough to push the Sun eastward by 3 min 57 s every day. If you could somehow replace the mercury in a mercury 2 10 m/s 14.1 m/s 51. What elements have
the greatest tendency to behave as reducing agents? What is the magnitude of the gravitational force between two 1-kg bodies that are 1 m apart? Reduction Note how these two reactions avoid the use of the zinc-corroding ammonium ion (which means alkaline batteries) and also prevent formation of any
gaseous products. These land plants occupied low wetland areas. This has been confirmed with direct measurements from space probes, which show an unusually high proportion of deuterium. Be glad water has a high specific heat capacity the next time you're enjoying cool watermelon on a hot day! 63. FIGURE 2.5 When you flip a coin in a
highspeed airplane, it behaves as if the airplane were at rest. F I G U R E 1 2 .1 5 Inserting the inner transition metals between atomic groups 3 and 4 results in a periodic table that is not easy to fit on a standard sheet of paper. A given mass of silver contains only about half as many atoms as an equal mass of iron, so only about half the heat is
needed to raise the temperature of the silver. They are phase-change processes between the liquid and gaseous states of water. A heavier person has to fall faster for air resistance to balance weight is more effective in "plowing through" air, resulting in a higher terminal speed for a heavier person. FYI Key Shallow Intermediate
Deep central Mississippi Valley. Which is more abundant: dark matter or ordinary matter? Nevertheless, the important concept is that the ratio of mass/volume is the same for any amount of water. One way to separate water from the mixture we call seawater, therefore, is to heat the seawater to about 100°C. Three kids sitting equal spaces apart
around a table are sharing jelly beans. This critical speed is called the escape speed or, if direction is involved, the escape velocity. This is osmosis, whereby water molecules migrate across a semipermeable membrane into regions of higher salt concentrations. 15.3 Ionic Bonds 7. A ir pressure, temperature, and density are three key variables that
control how air behaves, and hence they control the weather. (b) When the two protons are relatively far from each other, the electric force is more significant and the protons repel each other. Of these physicists, Leo Szilard (1898-1964) first envisioned the idea of a chain nuclear reaction. Velocity involves direction as well as magnitude; speed
involves only magnitude. 4 The pair of stars in the end of the Big Dipper's bowl point to the North Star. Three common alcohols and their melting and boiling points are listed in Table 19.2. More than 11 billion pounds of methanol, CH3OH, are produced annually in the United States. That connection awaited Newton's second law. As we learned in
Chapter 9, the vibrating electric and magnetic fields regenerate each other to make up an electromagnetic wave. 2 Unsaturated Hydrocarbons 19. Sugar and salts in the canned goods prevent them from freezing at 0°C. A chemical formula shows the ratio of atoms that constitute the compound. The few that have neutrons, however, are heavier, and
because of this difference they can be isolated. Eon Era Period Subperiod Epoch Ma Holocene 0.01 Quaternary Pleistocene 54.8 Paleocene 65 144 Phanerozoic Mesozoic Jurassic (first bird) Triassic 206 248 Permian (first reptiles) 290 Pennsylvanian 323 Mississippian 354
14.007 15.999 11 12 13 14 15 16 AI Si 26.982 31 28.086 32 N P O S He 4.003 10 F Ne 18.998 17 20.180 18 Cl Ar 35.453 35 39.948 36 Na Mg 22.990 19 24.305 20 3 4 5 21 22 23 24 25 26 27 28 29 30 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 39.098 37 40.078 38 44.956 39 47.88 40 50.942 41 51.996 42 54.938 43 55.845 44 58.933 45 21 22 23 24 25 26 27 28 29 30 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 39.098 37 40.078 38 44.956 39 47.88 40 50.942 41 51.996 42 54.938 43 55.845 44 58.933 45 21 22 23 24 25 26 27 28 29 30 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 39.098 37 40.078 38 44.956 39 47.88 40 50.942 41 51.996 42 54.938 43 55.845 44 58.933 45 21 22 23 24 25 26 27 28 29 30 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 39.098 37 40.078 38 44.956 39 47.88 40 50.942 41 51.996 42 54.938 43 55.845 44 58.933 45 21 22 23 24 25 26 27 28 29 30 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 39.098 37 40.078 38 44.956 39 47.88 40 50.942 41 51.996 42 54.938 43 55.845 44 58.938 40 50.948 30 Ne Cu Zn Ga Ge As Se Br Kr 39.098 37 40.078 38 44.956 39 47.88 40 50.942 41 51.996 42 54.938 43 55.845 44 58.938 40 50.948 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.938 41 51.996 42 54.9
63.546 47 65.39 48 69.723 49 72.61 50 74.922 51 78.96 52 79.904 53 83.8 54 6 7 8 9 10 58.69 46 Rb Sr Y Zr Nb Mo Tc Ru Rh 85.468 55 87.62 56 88.906 77 Pd Cs Ba La Hf Ta W Re Os Ir 132.905 87 137.327 88 138.906 89 178.49 104 180.948 105 183.84 106 186.207 107 190.23 108 192.22
83 127.60 84 126.905 85 131.29 Bi Po At Rn 209 116 210 117 222 118 Uuh Uus Uuo 70 71 208.980 115 Uuq Uup 289 66 67 32.066 34 86 292 68 69 Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu 140.115 90 140.908 91 144.24 92 145 93 150.36 94 151.964 95 157.25 96 158.925 97 162.5 98 164.93 99 167.26 100 168.934 101 173.04 102 174.967
103 Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr 232.038 231.036 238.029 237.048 244 243 247 251 252 257 258 259 262 *At the time of this publication, elements 114 and 116 were confirmed but yet to be officially named. In the case of a sailboat cutting across the wind, the wind may continue to make impact with the sail even after the boat
exceeds wind speed. Reduction is the opposite process, whereby a reactant gains one or more electrons. But some phthalates, such as DINP, have been shown to be safe. These compounds can precipitate from solution and partially fill the pore spaces with mineral matter. Hybrids have improved gas mileage because as the car slows down, its kinetic
energy is transformed into the electric potential energy of the battery rather than being wasted as heat from the car's brake pads. Sometimes, enough evaporation occurs that raindrops disappear before reaching the ground. Similarly, the atomic mass of an element is the average mass of all the various isotopes of that element. The outside
temperature could drop to well below freezing, but not in the cellars, where water was releasing thermal energy while undergoing freezing. Electrons in the circuit are moved first dc in one direction and then in the opposite direction, alternating to and fro about relatively fixed Time positions. How interesting that these atoms then join together to
based on the trend of the weather pattern. 3 4 PROLOGUE T H E N AT U R E O F S CI E N CE Facts are revisable data about the Theories world. See any of Hewitt's Conceptual Physics textbooks for more information. 95. High clouds (other than cirrus clouds) are denoted by the prefix cirro-. Cite a way that the energy value of foods is determined
This explains why the inner surface of tea kettles are often coated with calcium carbonate residues. What is the approximate mass of two oxygen atoms? Chemical change can produce electricity, so it makes sense that electricity can produce chemical change can produce electricity can produce electricity can produce electricity.
hard water. 44. From the equilibrium rule, g F = 0, the upward forces are 800 N, and the downward forces are 500 N + the weight of the scaffold. ont Top view of sidewalk Grass Angle of incidence r vef a W Air Angle of refraction Water F I G U R E 11 .1 9 INTERACTIVE FIGURE F I G U R E 11 .1 7 F I G U R E 11 .1 8 The
direction of the rolling wheels changes when one wheel slows down before the other does. (a) CHECKPOINT 1. I think it is much more interesting to live not knowing than to have answers that might be wrong." —Richard Feynman LEARNING OBJECTIVE Apply the independence of horizontal and vertical motion to projectiles. F = k q1q2 V V2 P = IV
= a b V = . What does the pH of a solution indicate? F I G U R E 1.1 5 CHECKPOINT You push on a piece of furniture and it slides at constant speed across the living room floor. What might happen to the free-base form of caffeine dissolved in diethyl ether if gaseous hydrogen chloride, HCl, were bubbled into the solution? The vertical distances
traveled are the same as if the ball were simply dropped. These radio-wave frequencies at which F I G U R E 1 0. The lobe-finned fishes are an important link to amphibians, which made their appearance during the late Devonian. In many instances, direct absorption of electromagnetic radiation is sufficient to break chemical
bonds and to initiate a chemical reaction. Since calcium and strontium are in the same group, they have similar physical and chemical properties. Sodium, Na, has the weakest electronegativity, which means it is the strongest reducing agent of these three elements. So, strictly speaking, when you step off the curb, the street rises ever so slightly to
meet you. Epicenter ect dir es No wav P- VIDEO: The Mantle and Crust No P-w dire ave ct s 558 CHECKPOINT What evidence supports the theory that Earth's inner core is solid and its outer core is liquid? (d) alternating voltage only, not current. Breathing the high-pressure air causes excessive amounts of nitrogen to dissolve in body fluids,
especially the blood. (b) C, B = D, A. Our current speculations are just that—speculations. If you understand these ideas, you can understand why there is a 10.3-m limit on the height to which water can be lifted with vacuum pumps. It is theorized that X-rays and visible light are emitted only during a pulsar's early history. Although the salinity varies
from one part of the ocean to another, the overall composition of seawater is fairly uniform—about 96.5% water and 3.5% salt. Note that speed is shown in units of km/h and mi/h. Together, the rising warm updraft and the sinking, chilled downdraft make the cloud into a storm cell. Such an orderly array of ions is known as an ionic crystal. The
distances go from zero to 1 meter in 1 second, zero to 4 meters in 2 seconds, zero to 9 meters in 3 seconds, zero to 1 meters in 3 seconds, zero to 1 meters in 3 seconds, zero to 1 meters in 2 seconds, zero to 1 meters in 3 seconds, zero to 1 mete
substituting v = at, we get Fd = 12 mv2. 112 PA R T O N E P H Y S I CS R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 1. It also converts ac to dc by means of a diode inside—a tiny electronic device that acts as a one-way valve. Because these forces act for the same amount of time, the impulses are also equal and opposite. 408 PA R
T T W O CH E M I S T RY Grease is soluble in paint thinner, which is why paint thinner can be used to clean one's hands of grease. Doubling one charge doubles the force. Show that the hydroxide-ion concentration is 1 * 10-10 M. The tail of the comet leaves behind a wide trail
of particles. We see evidence for the law of inertia when the horizontal motion of the coin before, during, and after the catch is the same. Rock can undergo elastic deformation, brittle deformation, brittle deformation, brittle deformation, brittle deformation. If the anvil is more massive than the astronaut, which shakes more—the anvil or the astronaut? These "exoplanets" reveal
themselves by causing slight but detectable wobbles in the star they orbit. The effects of regional metamorphism are most pronounced in the cores of deformed mountains. Pushing into a coil with 10 times as many loops induces 10 times as much voltage; and so on.
In fact, you can't push on the wall unless the wall pushes back. Sometimes the changes aren't noticeable, and sometimes the gravitational pull between it and Earth. Only two structural isomers are drawn.
How many Milky Way diameters distant is the Andromeda galaxy? This is a "coming together" of matter, which suggests a decrease in entropy. In the case of the wooden block, the weight on the scale doesn't change. Notice that the water doesn't simply fall out but gurgles out of the container instead. What does the color of a star tell you about the
star? One model suggests they arose from large amounts of material falling into our galaxy's mega-size central black hole. The relationship among voltage, current, and resistance is summarized by a statement called Ohm's law. Dark matter is about six times more abundant than ordinary matter. An ester is an organic molecule similar to a carboxylic
acid except that in the ester, the hydroxyl hydrogen is replaced by a carbon. Hewitt Oregon State University Archives (left) Pearson Education/Pearson Science (bottom right) Pearson Education/Pearson Science (bottom right) Pearson Education/Pearson Education/Pears
in the lamp is 2 A, the current in the battery is (a) half, 1 A. The 1989 Loma Prieta earthquake near Santa Cruz, California, magnitude 7.1, caused 62 deaths and more than $6 billion in damage. R O CK S A N D M I N E R A L S Melting starts F I G U R E 2 0 .1 7 The temperature inside Earth increases about 30°C for each kilometer of depth from the
surface deep into the continental crust (the gradient is much lower in the deep crust and mantle). A spacecraft on its way from Earth to the Moon when it is (a) closer to Earth's surface. Slow stirring causes the gelatinous material to clump together and settle to the bottom of the basin. The tendency of the ball
is to remain at rest. Table 15.1 lists some commonly encountered polyatomic ions. Interestingly, the term mole is derived from the Latin word moles, meaning heap, mass, or pile.) One mole of gold atoms, for example, is 6.02 * 1023 gold atoms, for example, is 6.02 * 1023 gold atoms, and 1 mole of sucrose molecules is 6.02 * 1023 gold atoms, for example, is 6.02 * 1
improve conditions on planet Earth. Both of these forces act simultaneously. The minerals quartz and olivine display smooth conchoidal fractures (Figure 20.9). 31 F I G U R E 11. What pledge has been made by members of the American Chemistry Council through the Responsible Care program? Common sense tells you to choose the haystack. In the
first figure, the lever arm is shown by the dashed line and is less than the length of the wrench handle. Choose the most likely set of mass numbers for these two bromine isotopes: (a) Br-79, Br-81; (b) Br-79, Br-80; (c) Br-80, Br-81. 22.990 g 6.02 1023 atoms, which is 1 mole 207.2 g 6.02 1023 atoms, which is 1 mole 4.003 g 6.02 1023 atoms, which is
1 mole C H A P T E R 17 a 22.990-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sample of lead, Pb (atomic mass = 207.2 amu), contains 6.02 * 1023 sodium atoms, and a 207.2-g sodium atoms, an
a floor consisting of basic minerals, such as limestone, are more resistant to acid rain because the chemicals of the limestone (mostly calcium carbonate, CaCO3) neutralize any incoming acid. (b) What is the gain in potential energy of the load? The momenta of two firecrackers approaching each other may cancel, but when they explode, there is no
way their energies can cancel. The underlying physics of an electric motor is that (a) electric and magnetic fields repel each other. What is absorbed by water to give it a cyan color? What is the support force exerted on the jug by the table? Air that is in contact with these surface "hot spots" rises, expands, and cools. How does it do this? Then wink.
Science types prefer kilopascals (1 kPa = 1000 Pa). This is constructive interference (Figure 10.19). (b) Show that the force of impact is 4500 N. Ethanol, for example, is infinitely soluble in water. Meanwhile, the negative hypochlorous acid.
continues to react with hydrogen chloride to form water and poisonous chlorine gas, Cl2, which is why bleach and toilet bowl cleaner should never be mixed together. 30. How many atoms are there in a 6.941-g sample of lithium, Li (atomic mass g 6.941 amu)? This type of wave is called a transverse wave. Also, because a diamond is a group of atoms
held together only by covalent bonds, it can be characterized as a single molecule! Unlike most other molecule is large enough to be visible to the naked eye, and so it is more appropriately referred to as a macromolecule. Large particles, like large bells, mostly scatter low frequencies. Do you see that the height of the step, the
radius of the wheel, and the angle of the applied force determine whether the wheelbarrow can be pushed over the step? What is its name? A double bond, therefore, consists of four electrons, while a triple bond consists of six electrons. Wear safety glasses and remove all combustibles, such as paper towels, from a clear countertop area. However,
this quantity of hydrogen gas at room temperature and atmospheric pressure would occupy a volume of about four midsize cars! Thus, the major hurdle to the development of fuel-cell technology lies not with the cell but with the fuel. Europeans thought like Aristotle, and the existence of a force big enough to keep Earth
moving was beyond their imagination. Minerals commonly crystallize from two different sources: from magma—molten rock—and from water solutions. FIGURE 9.32 A practical transformer. Give exaggerated examples to support your answer. When viewed from afar, all of these stars—along with our own star, the Sun—appear as a great swirl of
stars known as a galaxy. Aerobic bacteria decompose organic matter only in the presence of O2, transforming organic matter into odorless carbon dioxide, water, nitrates, and sulfates. A vacuum cleaner operates on Earth because the atmospheric pressure pushes dust into the machine's region of reduced pressure. Chemical properties have to do
with electron structure, which is determined by the number of protons in the nucleus, not the number of neutrons. Why is it important that a satellite remain above Earth's atmosphere? We find, however, that this doesn't happen. Compared with conventional water heaters in the United States, why do propane tank-less water heaters, common in
other parts of the world, cost up to 60% less to operate? Why is calcium fluoride, CaF2, a high-melting-point crystalline solid, while stannic chloride, SnCl4, is a volatile liquid? (b) metallic bond. The car moves up a greater distance than the oil level drops, because the area of the piston is smaller than the surface area of the oil in the reservoir. The
result is more-crowded streamlines along the top wing surface than along the bottom. Using as a guide the rules that a good radiation is a good radiation groperties of a surface. Wind can generally move only small particles. Some familiar ones are
listed in Table 19.4. Esters are fairly easy to synthesize by dissolving a carboxylic acid, H2SO4. (Many people give the wrong answer to the preceding question because they assume that because the balls end up with the same speed, they roll for
the same time. Dispersion The separation of light into colors arranged by frequency. Would you expect metals to be more abundant in old stars or in new stars? 776 PARTFOURE 28.7 This image from NASA depicts the early history of the universe starting with the Big Bang. Sodium metal FIGURE 14.16 and chloring gas
react to form Sodium atom Chlorine atom Sodium chloride, NaCl Hydrogen atom Nitrogen atom Nitrogen atom Nitrogen atom NH3. This mutual attraction between hydrogen and the negatively charged atom of another molecule is a hydrogen
bond. In the hydrogen-oxygen fuel cell, chemical change is used to produce electric current is a flow of charged particles. Two reasons: preparedness and economics. For example, mica's crystal structure consists of atoms
arranged in sheets. Would this reactor have reached the critical stage with natural uranium? Speaking more generally, a star's hydrogen-burning lifetime lasts for a period of a few million to 50 billion years, depending on its mass. Light slows down upon entering the blocks. How do the average kinetic energies of hydrogen and oxygen gases compared
when these two gases are mixed at the same temperature? Hydraulic conductivity is the ability of a material to transmit water. The wave pattern is distorted and is no longer composed of concentric circles (Figure 5.16 is nicely
employed by the Falkirk Wheel, a unique rotating boat lift that replaces a series of 11 locks in Scotland. 1 S TARSANDGALAXIES 753 C ALCULATEDRADIIOFEVENTHORIZONSFORNONROTATINGBLACKHOLES OF VARIOUS MASSES Mass of Black Hole 1 Earth mass 1 Jupiter mass 1 solar mass 2 solar
masses 3 solar masses 5 solar masses 5 solar masses 10 solar masses 10 solar masses 100 sol
phase. CHAPTER 4 4.1 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L I T E S The Universal Law of Gravity EXPLAIN THIS What exactly did Newton discover about gravity? As these originally flatlying sedimentary rock layers are subjected to compressive stress, they tilt and C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T
ERIOR Compressive stress Anticlines Syncline 575 FIGURE 21.30 These photos show a cross-section of wax layers subjected to compressive stress. This makes LDPE more bendable than HDPE and gives it a lower melting point. The ease with which voltages can be stepped up or down with a transformer is the principal reason that most electric
power is ac rather than dc. Though invisible to the naked eye, these bubbles span over half the sky when viewed from Earth through gamma ray detectors. We may therefore suppose the velocity to be so increased, that it would describe an arc of 1, 2, 5, 10, 100, 1000 miles before it arrived at the Earth, till at last, exceeding the limits of the Earth, it
should pass into space without touching." —Isaac Newton, System of the World 106 PARTONEPHYSICS LEARNING OBJECTIVE Describe why speed remains constant for a satellite in circular orbit. (A combination of magnetic and electric fields is used in particle accelerators such as cyclotrons. Which elements tend to form covalent bonds? (c)
spirals out indefinitely. Birds fly by pushing air downward. t = d \cdot 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 105 \text{ h} a different out indefinitely. Birds fly by pushing air downward. t = d \cdot 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 105 \text{ h} and t = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 108 \text{ km} = v \cdot 1000 \text{ km/h} = 1.5 * 1000 \text{ km/h} = 1.
molecule than TiO2. ! FIGURE 4.9 Both are weightless. In Einsteinian space-time, these four dimensions merge. Because these stars are red, we know they must have low surface temperatures. Water. m 30,000 kg 45. This makes the machine and its surroundings warmer. The periodic table has 7 periods and 18 groups. Claims that the Earth is flat or
claims for the existence of flying saucers are quite harmless and may amuse us. One light-year is the distance that light travels in 1 year, nearly 10 trillion km. Furthermore, if a galaxy were to move from where we are now to its present location with a velocity v, then the time of this trip would be the distance it travels divided by its velocity: t = d v
We use Hubble's law to substitute for v: t = d 1 = H * d H When we enter the value of H into this equation, we have an estimate of the interval of time for the expansion. The mantle is Earth's thickest layer and makes up about 84% of its volume. If you stand on a large ship, the force of attraction between you and the ship is too weak for ordinary
measurement. Symmetry is often the greatest clue for determining polarity. That's where friction with the floor comes into play (Figure 2.27). What measures can be taken to prevent further oil spill disasters? What would be the final temperature of a mixture of 50 g of 20°C water and 50 g of 40°C water? LEARNING OBJECTIVE Relate magnetic field
strength to electric wire configurations. 16.3 Solutions 7. Minerals that do not have a metallic lus- comes in a variety of colors as ter generally leave behind a white streak, which is not useful for identification. Discuss how mass is the crux of these questions. 752 PA R T F O U R ASTRONOMY Black Hole Geometry Light rays F I G U R E 2 7. They must
strive to distinguish between what they see and what they see and what they see and what they wish to see, for scientists, like most people, have a vast capacity for fooling themselves.** People have always tended to adopt general rules, beliefs, creeds, ideas, and hypotheses without thoroughly questioning their validity and to retain them long after they have been shown to be
meaningless, false, or at least questionable. When warmed, air expands, becomes less dense, and is buoyed up(a) ward in the cooler surrounding air like a balloon buoyed upward. What happens to the other half? (b) a straight-line path. Suppose we position a paint gun at the center of a sphere with a radius of 1 m, and a burst of paint spray travels 1
m to produce a square patch of paint that is 1 mm thick. In his honor, four moons are known as the Galilean moons—from left to right: Ganymede, Callisto, Io, and Europa. Does a liquid release energy or absorb energy when it changes into a gas? The waves move from one person to the other along the length of the Slinky. Based on atomic size, which
would you expect to be more soluble in water: helium, He, or nitrogen, N2? New cells arising from the damaged cell retain the altered genetic information, producing a mutation. This is similar to the process of crystallization from magma, but the changes of phase occur in reverse order. In fact, the odor of elemental sulfur is negligible compared with
that of hydrogen sulfide. Perhaps your instructor will demonstrate the effects of the electric field that surrounds the charged dome of a Van de Graaff generator (Figure 8.12). Add a teaspoon of white vinegar to one cup and a teaspoon of baking soda to the second cup. Inserting the inner transition metals into the main body of the periodic table as in
Figure 12.15 results in a long and cumbersome table. Yes, because no acceleration means that no change occurs in velocity or in momentum (mass * velocity). Measuring equal masses of the two materials would not provide equal numbers. The system accelerates in accord with Newton's second law. As the universe continues to expand, its average
temperature should decrease. A catalyst is unchanged by a chemical reaction. In the forward reaction (left to right), H2PO4- gains a hydrogen ion to become H3PO4 is a gas, added to the water simply bubbles back out into the atmosphere. Newton's interest in mechanics was rekindled with the
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advent of a spectacular comet in 1680 and another two years later. This results in air above that is warmer. Therefore, it tends to form the 2+ ion. We know that water boils at 100°C at sea level. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Big Bang The primordial creation and
expansion of space at the beginning of time. Beta particles are not as easy to stop as alpha particles are, and they can penetrate light materials such as paper or clothing. This electric current powers Earth's magnetic field. This flow is evident far outside Earth's surface. To test this hypothesis, Newton compared the fall of an apple with the "fall" of
the Moon. Although these steps are appealing, much progress in science has come from trial and error, experimentation without hypotheses, or just plain accidental discovery by a well-prepared mind. When only the toaster is operating and drawing 8 amperes, the total line current is 8 amperes. Add more sugar or water as necessary to obtain a clear
runny syrup. What is the mass of an oxygen atom in atomic mass units? Air resistance is not negligible for the lighter Styrofoam ball, which reaches its terminal velocity sooner. But kinetic energy is a nonvector (scalar) quantity, like mass, and can never be canceled. b, 3. As air rushes into the lowpressure vortex, it expands, cools, and condenses into
a funnel cloud. What are the advantages and disadvantages and disadvantages of each model? 32 PA R T O N E P H Y S I CS 1.5 The Equilibrium Rule 12. The risks of technology are not always immediately apparent. As Figure 16.14 shows, therefore, an aqueous solution that has a concentration of 342 g of sucrose per liter of solution also has a concentration of 6.02 *
1023 sucrose molecules per liter of solution or, by definition, a concentration of 1 mole of sucrose per liter of solution. As Figure 11.41 shows, sunlight travels through more atmosphere at sunset, which is why sunsets are red. With continued stress, rocks at depth store up elastic energy. One of these products is a common food preservative. Which is
stronger: the ion-dipole attraction or the induced dipole-induced dipole-induced dipole-induced dipole-induced dipole attraction? 7 Circular Satellite Orbits 4. The energy and material abundance that is the expected outcome of a fusion age will likely prompt fundamental changes. Assume the distance between these dots is 5 mm. When two diffropical (mT) ferent air masses meet, a variety of
weather conditions can develop. This won't occur when the appliance casing is grounded via the ground wire, which ensures that the appliance casing is at zero ground potential. With such curvature, parallel lines may eventually meet or diverge. CHAP TER 26 26.1 The Solar System and Its Formation EXPLAIN THIS O How is gravity responsible for
solar energy? Both types of bracelets were identical, were supplied by the manufacturer's recommendations. C Ti 301 73 74 43 75 44 76 45 77 Cs Ba La Hf Ta W Re Os Ir 87 88 89 104 105 106 107 108 109 46 78 47 79 48 80 49 81 50 82 51 83 84 Pt Au Hg Tl Pb Bi Po At Rn 110 111 112 113 114 115 116
117 118 Fr Ra Ac Rf Db Sg Bh Hs Mt Ds Rg Cn Uut Uug Uup Uuh Uus Uuo 58 59 60 61 62 63 64 65 66 67 68 69 70 90 91 Metal 92 93 94 95 96 97 98 99 100 101 102 103 U Np Pu Am Cm Bk Cf Es Fm Md No Lr Metalloid Nonmetal Not yet confirmed As shown in Figure 12.9, most of the known elements are metals, which are defined as elements that
are shiny, opaque, and good conductors of electricity and heat. Rank these three types of radiation by their ability to penetrate this page of your book, from highest to lowest: (a) alpha particle, (b) beta particle, (c) gamma ray. If action is B acting on B, reaction is B acting on A. It therefore loses speed. This means that an object shot outward at 11.2
km/s (about 25,000 mi/h) will never fall back to Earth. An antenna-fed television (not cable or satellite) tuned into a channel with no local station shows a screen of static "snow." Interestingly, about 1% of this snow is due to photons from the cosmic background radiation. Both would be in free fall and hit the ground at the same time. Waves travel
across the grass, while the individual blades of grass remain in place; they swing to and fro between definite limits, but they go nowhere. (d) not matter because such a sudden halt to expansion would knock all galaxies and planets off their orbits and we would no longer be here to talk about it. Zetterberg with Tomas and Barbara Brage. The
Sovietbuilt Chernobyl nuclear power plant that reached meltdown in 1986 had no such containment building, so massive amounts of radiation were released into the environment. (d) Light travels so fast that the curvature is not noticeable. Pressure is exerted everywhere against the object in a direction perpendicular to its surface. Show that its
frequency of swing is 13 Hz. Period g 1 frequency 40. Energy must be put into a substance to change its phase in the direction from solid to liquid to gas. Forces are interactions between different things. Air is heavy, if you have enough of it. The planets range greatly in size, but the Sun dwarfs them all—containing more than 99% of the mass in the
solar system. Is it true that a fish can drown in water? This reaction produces a hydronium ion, which react together to re-form the water molecule: 

LEARNING OBJECTIVE Calculate the pH of a solution given the hydronium ion, which react together to re-form the water molecule: 

LEARNING OBJECTIVE Calculate the pH of a solution given the hydronium ion, which react together to re-form the water molecule: 

LEARNING OBJECTIVE Calculate the pH of a solution given the hydronium ion concentration.
space. In this way, evaporation occurs in the mouth and within the bronchial tract. Which part of an atom is positively charged, and which part is negatively charged.
including DNA, proteins, the cellulose of plants, and the complex carbohydrates of starchy foods. The one that killed off the dinosaurs occurred about 65 million years ago, and it is thought to have been the result of the impact of a large asteroid. Galileo showed that experiments are superior to logic in testing knowledge. Fact A phenomenon about
which competent observers who have made a series of observations are in agreement. In general, the outer-shell electrons of atoms in the same group of the periodic table are similarly organized. 18.5 Losing and Gaining Electrons of atoms in the same group of the
electron. Iron corrodes when it reacts with atmospheric oxygen and water to form iron oxide trihydrate, which is LEARNING OBJECTIVE Compare and contrast the processes of corrosion and combustion. Buoyant force Gravity Buoyant force Gravity C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R 561 Sea level
Continental crust Oceanic crust Root Mantle 0 10 20 30 40 50 60 70 Depth (km) FIGURE 21.9 Continental crust is thicker and less dense than oceanic crust. 1 General Structure O R G A N I C CO M P O U N D S 497 FUNC TIONAL GROUPS IN ORGANIC MOLECULES Class General Structure Class O C OH Alcohols C O C C H Aldehyde group
100°C, the volume is 100 273 greater than it is at 0:::C. Hydronium ions are responsible for the corrosive action. Pressure is depth dependent, not volume dependent. That rule and the conservation of energy are dominant players in the universe. The shells begin to dissolve, forming a noncrystalline ooze of calcium carbonate. White - red = 1. In 1998
a minister in Jacksonville, Florida, dramatizing his sermon before several hundred parishioners, including his family, shot himself in the head with a blank round from a .357-caliber Magnum. (d) a straight-line path. Would you really be weightless? If an object is moving, then it is capable of doing work. 12. What is the first step in treating raw sewage?
By sucking, you reduce the air pressure in the straw when it is placed in a drink. 19 C H A P T E R 1 9 Organic Compounds Vanillin Tetramethylpyrazine C arbon atoms are perhaps the 19. This is the work-energy theorem. When the oceans are warm, they release more carbon dioxide relative amounts of carbon-14. So by the time you (or rarefactions).
Would you expect a glass of water to evaporate more quickly on a windy, warm, dry, summer day or on a calm, cold, dry, winter day? Inelastic collision A collision in which the colliding objects become distorted, generate heat, and possibly stick together. c Choose the BEST answer to each of the following. (c) force of gravity is the same for both. But
Earth is dynamic and ever changing—and spreading rates can change. In most common magnets, electron spin is the main contributor to magnetism. 42. Recrystallization occurs within a rock because of exposure to high temperatures and/or pressures, without melting. Well-rounded particles imply a long distance. Br .. So by measuring
the periods of the distant Cepheids, Hubble was able to calculate their luminosities. Because the voltage across each branch is inversely proportional to the resistance of the branch is inversely proportional to the resistance of the branch is inversely proportional to the resistance of the branch is the same, the amount of current in each branch is inversely proportional to the resistance of the branch is inversely pr
how a helicopter gets its lifting force. Warm air wants to rise. Learn these underlying rules (physical laws), and you have a tool kit to bring to any phenomenon you wish to understand. Consider the simple case of water waves (Figures 10.4 and 10.5). Not so for the nuclear reactions discussed in Chapter 13. They are quiet environments because they
are sheltered from the battered coast. When the pointer stops, the elastic force of the deformed spring balances the gravitational attraction between you and Earth—nothing moves, because you and that donates a proton
and a base is a chemical that accepts a proton. S F I G U R E 9 .1 A horseshoe magnet. Two English geologists, Fred Vine and Drummond Matthews, puzzled over Hess's hypothesis of seafloor spreading and their new magnetic data. (d) metamorphism.
substances, but a submicroscopic view shows that both consist of water molecules. arthquakes, besides being fearsome and destructive events, provide a key to understanding Earth's internal systems, we call it the first law of
thermodynamics. The electrical force of attraction weakens with increasing distance. Methane, on the other hand, is nonpolar because of its symmetrical structure, which results in no net dipole and a relatively low boiling point. They each formed from rocky and metallic cores that were much more massive than the terrestrial planets. 114 PA R T O N
EPHYSICS 50. CHAPTER 5 longer than one of mercury (of the same cross-section) is needed to provide the same weight as mercury in the tube. As a consequence, gases that come out our other ends are frequently of the same weight as mercury in the tube. As a consequence, gases that come out our other ends are frequently of the same weight as mercury in the tube. As a consequence, gases that come out our other ends are frequently of the same weight as mercury in the tube.
batholiths (Figure 20.22). Heat the top part in a flame until the water boils. Deposition is the stage in which eroded particles come to rest. Moon phases The cycles of change of the "face" of the Moon, changing from new, to waxing, to full, to waning, and back to new. A less spectacular but more recent supernova F I G U R E 2 7.1 5 The Crab Nebula
is the remnant of a supernova explosion first observed on Earth in AD 1054. As discussed in Section 15.8, in our comparison of induced dipole-induced dipole attractions than smaller hydrocarbons do. The pressure of the atmosphere is pushing against the
hemispheres and the piston. In a polar bond or molecule, electrons are congregated to one side. (a) v = 60 km/h - 40 km/h = 20 km/h. Tripled? The most immediate, effective, and low-cost way to reduce soot emissions is to put particle traps on vehicles, diesel trucks, buses, and construction equipment. Without polar molecules in the food, a
microwave oven wouldn't work. Whereas momentum depends on velocity (mv), kinetic energy depends on the square of velocity 1 12mv2 2. (Hint: Let the equation for gravitational force guide your thinking.) 68. The Teflon molecule, part of which is shown in Figure 15.41, is a long chain of carbon atoms chemically bonded to fluorine atoms, and the
fluorine atoms exert essentially no attractions on any material in contact with the Teflon surface—an omelet in a frying pan, for instance. The concentration of hydronium ions in most solutions is typically much less than 1 M. 24. In the United States, the vibrational rate is 60 Hz. Ampere The unit of electric current; the rate of flow of 1 coulomb of
charge per second. 20.3 Mineral Properties 7. Hydrogen chloride is a remarkably corrosive acid, which makes it useful for cleaning toilet bowls and etching metal surfaces. The Physical Sciences: Physics, Chemistry, Earth Science, and Astronomy 15.
Intake Outlet Intake The aneroid barometer. The simplified model that we present here—of an atom whose electrons vibrate as if on springs, with a time interval between absorbing energy and re-emitting it—is quite useful for understanding how light passes through a transparent material. Now, repeat this, only with the paper on top of the book, not
sticking over its edge. Can you think of things in your own life that remain constant as other things change? irt and grease together make grime. While bathing in the warmth of a natural hot spring, she wonders aloud how the spring gets its heat. Both accelerate at 2.5 km/h # s. The rock cycle varies in its paths. This kinetic energy released by the
reaction is equal to the difference between the potential energy of the presence of the presen
 thousands of set-to-kill spring-action mouse traps? Short wavelengths of visible light interact more frequently with the atoms in glass than do longer wavelengths. Use this distance to calculate your hang time. Imagine an old hermit who lives in the mountains. Heavy, iron-rich elements sank to early Earth's center; lighter, silicate elements migrated
toward the surface. Millions of drops produce the entire spectrum of visible light. Which is the solvent: sucrose or water? Less force means less chance of breakage. These are all aspects of a broad theory known as the molecularkinetic theory. Hewitt (a, b, c) Richard Megna/ Fundamental Photographs, NYC (bottom) Shutterstock 222: Johnne the solvent: sucrose or water? Less force means less chance of breakage.
Suchocki/Paul G. But when you jump upward, with your feet no longer in contact with the floor, why doesn't the high-speed wall slam into you? Because of this, mass and weight are often interchanged. The Breeder Reactor One of the fascinating features of fission power is the breeding of fission fuel from nonfissionable U-238. (a) What change is
there in the light's frequency in the plastic? A pair of electrons spinning in opposite directions, however, work against each other. (d) an adiabatic process. Light from a light source becomes dimmer with distance. Is this a physical or chemical change? Bubbles do not form until the boiling point is reached. 129. The second form of matter generated
from the Big Bang is quite unlike ordinary matter. (3) The ions are then held together by an ionic bond. Atoms that tend to form bonds).
Observations and careful measurements of their behavior can offer additional clues. With stick and strings, make a "trajectory stick" as shown on page 101. The outer electrons of most metal atoms tend to be weakly held to the atomic LEARNING OBJECTIVE nucleus. Write a letter to your grandparents and tell them the reasons for the blueness of the
sky, the redness of sunrises and sunsets, and the whiteness of clouds. 4.8 Elliptical Orbits 27. Were the hemispheres sucked together or pushed together or pushed together or pushed together or pushed together. The dune reveals itself to be made of tiny particles of sand. See also Galaxies giant, 743 Hertzsprung-Russell diagram for, 743-744 life cycles of, 745-750 neutron, 750 ne
observation of, 739-740 radiation curves of, 742-743 white dwarf, 743 Static charge, 600 gradient, 600 Stream valleys, 605-606 Strong nuclear force, 326-328 Structural isomers, 491 Subatomic
particles, 297-299 Subduction, 569-572 Sublimation, 174, 610 Superconductors, 199 Superconductors, 279 Sun, 712-714 eclipse of, 726, 727-728 Sunsets, color of, 280-281 Superconductors, 199 Superconductors, 199 Superconductors, 199 Superconductors, 279 Sun, 712-714 eclipse of, 726, 727-728 Sunsets, color of, 280-281 Superconductors, 279 Sun, 712-714 eclipse of, 726, 727-728 Superconductors, 279 Superconduc
dating and, 621 Support force, 22 Surface currents, oceanic, 672-675 Surface water, 599-608 erosion and, 604, 605 stream valleys and, 605-606 turbulent flow of, 604 Surface waves, 556, 557 Suspensions, 401 Sympathetic vibrations
247 Synclines, 575 Systems, action-reaction, 50-51 T Technology, science and, 8-9 Tectonic plates. In the 1960s, when testing of nuclear weapons was very common, underground nuclear explosions were found to produce seismic waves. Galaxies are cataloged by two systems. C H A P T E R 15 H O W ATO M S B O N D A N D M O L E CU L E S AT T
R AC T 389 Induced dipole- induced dipole- induced dipole- induced dipole attraction Iodine molecules Negligible intermolecular attractions δ δ δ δ Electrons can bunch to one side without experiencing strong electrical repulsions among themselves. (d) all of these 7. Around a small intrusive body, such as a dike, the altered zone is very narrow and may
resemble "baked" rock, with a texture and appearance like ordinary brick. This polymer is composed of two different monomers, which classifies it as a copolymer. Your physics instructor drops a magnet through a long vertical copper pipe and it moves slowly compared with the drop of a nonmagnetized object. Different substances have different
thermal capacities for storing energy. * The Latin title means "Mathematical Principles of Natural Philosophy." See Newton's biography on page 53. More specifically, we say it's in static equilibrium. Soon all the molecules are aligned and vibrating about fixed positions. EXPLAIN THIS We know that it's harder to stop a large truck than a small car
when both are moving at the same speed. Small wonder it remains hot down there! few seconds after coming from the hot toaster, whereas you must wait several minutes before eating soup that has the same high temperature. And shale is metamorphosed to slate. While not yet operational, the latest Generation IV nuclear reactors will have
fundamentally different designs. Because of their great kinetic energies, however, alpha particles can cause significant damage to the surface of a material, especially living tissue. Natural gas and baking soda transform to carbon dioxide, water, and heat. 2 H O W ATO M S B O N D A N D M O L E CU L E S AT T R AC T 385 BO I L I NG PO I NTS O F
S O ME P O L A R A N D N O N P O L A R SUBSTANCES Substance Boiling point (°C) Polar Hydrogen, H2 Oxygen, O2 Nitrogen, H2 Oxyg
with low silica content and a higher melting point. Hewitt 240: Dave Eddy/Paul G. Second, you should NEVER question what you read in our literature." What advice do you offer? FIGURE 3.21 Potential energy to Potential + kinetic to Kinetic energy to Potential energy 
material things; anything you can touch, taste, smell, see, or hear is matter. The Tertiary period includes the Paleocene, Miocene, and Pliocene epochs. Buyer beware! Most bottled water sold today is simply municipal water that has been purified via reverse osmosis. Rather, it serves as a tool to help us understand and predict how
atoms behave. In what sense are we all made of star dust? The sections of lithosphere on opposite sides of the fracture zone are part of the same plate—both sides are moving in the same direction. Where and how would the Moon be positioned if the scenes were close to the North Pole? In this and the following chapter we will investigate the effects
of particle motions. Look for signs of cloud formation below the ice cube. From greatest to least, rank the frequency of radiant energy: (a) red-hot star, (b) bluehot star, and (c) the Sun. All the colors produce white, but all the colors minus one produce the color that is complementary to the missing color. Is it a mineral?
But the amount of matter would be the same. They are all of the fission type. Likewise, carbonic acid is unable to give away any hydrogen ions in a concentrated solution of such a strong acid. Airplanes cannot be made perfectly safe. Rank the amount of her face she sees in the three locations, from greatest to least (or is it the same in all positions?)
(a) Were these your answers? Can you feel the collisions? The average frequency of radiant energy is directly proportional to the absolute temperature results in an expansion of the water. When a neutron bounces from a carbon nucleus, the
nucleus rebounds, taking some energy away from the neutron and slowing it down so it will be more effective in stimulating fission events. How many poison molecules did you just drink? Without sufficient energy to climb to the top of the hill, the car cannot get to the other side. In addition to being depth dependent, liquid pressure is exerted equally
in all directions. Light reflecting from this page is diffuse. The positions of the stars then are compared with those in other photographs of the same area taken at other times during the night. This overpressure, suddenly followed by underpressure, suddenly followed by underpressure in the same area taken at other times during the night.
other substances, mostly water. E X E R C I S E S (SYNTHESIS) 46. We know that during the day, the primary source of light is the Sun, and a secondary source is the brightness of the sky. A scientific hypothesis, on the other extreme, we are
reminded of the planet Venus, which in earlier times may have had a climate similar to Earth's. Measure the temperature of boiling water and the temperature of boiling water and the temperature of a boiling solution of salt and water. What is the electric charge on the calcium ion in calcium chloride, CaCl2? The unit of frequency is called the hertz (Hz), after Heinrich Hertz, who
demonstrated the existence of radio waves in 1886. A common example of a longitudinal wave is (a) sound. Interestingly, the pressure within that water is relatively small! FIGURE 5.39 Air pressure above the roof is less than air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small! FIGURE 5.39 Air pressure within that water is relatively small within the pressure wi
15.29, do not cancel each other the way the C i O dipoles in Figure 15.25 do. The numbers of electrons and protons balance, so whether a wire carries a current or not, the net charge of the wire is normally zero at every moment. Ammonia, NH3, is the stronger base. REVIEW 83 22. So the Big Bang didn't explode right away. One way to see why is to
think about the work that must be done to separate a nucleus into its component nucleons. With the discovery of the midocean rifts, Hess was inspired to look back at his data from years before. Two sound waves of the same frequency can interfere with each other, but two sound waves must have different frequencies in order to make beats. What is
going on? Short wavelength Energy increases 1m Radio waves F I G U R E 11. But with filter 3 sandwiched at an angle between them, some light gets through 1 and 3 because their axes are at 45°, not crossed. 5 Convection currents in (a) a gas (air) and (b) a liquid. After a bottle of seltzer water is resealed, the carbon dioxide continues to come out of
solution to fill the head space inside the bottle. The ultrasonic waves emitted by a dolphin enable it to "see" through the bodies of other animals and people. Is the physics similar for the nails that stick to the magnet? For example, if you are trying to determine which of two small objects is heavier, you might shake them back and forth in your hands
or move them in some way instead of lifting them. The relative humidity increases because air is approaching its saturation point. SAM PLE PROBLEM 3 The Milky Way and Andromeda galaxies are about 2,300,000 light-years apart. All parts of the rigid merry-go-round turn about the axis of rotation in the same amount of time. He knew that the color
of light emitted by a star or galaxy receding away from us shifts to the red because of the Doppler effect (see Section 10.8). Why are silicon and oxygen concentrated at the core? A color-coded gradebook and diagnostic charts provide unique insight into class performance and summarize the most
difficult problems, vulnerable students, grade distribution, and even score improvement over the duration of the course. The amino acid lysine is shown here. Add a couple tablespoons of baking soda to the hot water. This pattern results because the peaks and valleys of successive waves are perfectly matched, which makes the waves reinforce one
another. We'll see its wave nature in how it refracts and how we see its colors, quite spectacularly as rainbows. Figure 15.16 uses the fluorine, F2. Likewise, the graphite in your pencil is an element—carbon. Likewise for any principle or concept for which there is no means, procedure, or test whereby it can be shown to be wrong (if it is wrong).
Precipitation occurs when the size of condensed drops grows to fall as rain, sleet, or snow. Remember that carbon-carbon double bonds cannot rotate but carbon-carbon double bonds cannot rotate. From Earth, we see only a single lunar side. Liquid water and water vapor interact chemically with rock to break it down. (d) either more or less mass per
nucleon, d, 3. This means that ice is less dense than water. A space probe is carried by a rocket into outer space. The ocean, therefore, is a carbon dioxide sink—most of the CO2 that goes in doesn't come out. The longer a plant or other organism is dead, therefore, the less carbon-14 it contains relative to the constant amount of carbon-12. He defined
are the same age, which is appreciably older than the solar system. For the specific heat capacity c, use 4190 J/kg # °C. We'll treat waves further in Chapters 11 and 12. Water, for example, looks quite different after it freezes, just as a car looks quite different after it rusts (Figure 14.11). Light bends in a gravitational field. In the Conceptual Physical
Science Practice Book, we present a fascinating aspect of special relativity that tells us how time changes with motion. Or a piece of toast may be comfortably eaten a * In the previous century when movies were new, audiences were amazed to see a train come to a stop inches away from a heroine tied to the tracks. As discussed in this chapter, the
greater the concentration of reactants, the faster the rate of the reaction. Seltzer water is a mixture of a liquid compound, water, and a gaseous compound, carbon dioxide. Discuss what is wrong with this scheme. A perpendicular collision between N2 and O2 tends not to result in formation of a product molecule. A characteristic of wave motion is
that the medium transporting the wave returns to its initial condition after the disturbance has passed. These charges balance in a one-to-one ratio, and so the formula for magnesium oxide is MgO. Most rainfall ends up in the oceans. The motion of the second fork is called a sympathetic vibration. (b) far from Earth. And can you see that when both
per nucleon The mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a helium-4, which results from the fusion of two hydrogen-2 nucleus is greater than the mass of each nucleon in a helium-4, which results from the fusion of two hydrogen-2 nucleus is greater than the mass of each nucleon in a helium-4, which results from the fusion of two hydrogen-2 nucleus is greater than the mass of each nucleon in a helium-4, which results from the fusion of two hydrogen-2 nucleus is greater than the mass of each nucleon in a helium-4, which results from the fusion of two hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a helium-4, which results from the fusion of two hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleon in a hydrogen-2 nucleus is greater than the mass of each nucleus is greater than the mass of each nucl
RY F I G U R E 1 6 .11 Water molecules pull the sucrose molecules in a sucrose crystal away from one another. WAV E S A N D S O U N D 243 FIGURE 10.9 (a) The radio loudspeaker is a paper cone that vibrates in rhythm with an electrical signal. Consider a large quantity of U-235 divided into two pieces, each with a mass less than critical. Consider a large quantity of U-235 divided into two pieces, each with a mass less than critical.
a pair of incandescent bulbs, a 60-W bulb and a 100-W bulb. Which has the least electron gativity? Photons are emitted when electrons cross a "band gap" in the device. See Think and Solve 36. fashion. If opposite poles are brought together, however, attraction occurs:* Like poles repel; opposite poles attract. Interestingly, most insects do not flap
their wings up and down. There is a limit to how much of a given solvent, as Figure 16.13 illustrates. Hexanol, butanol, ethanol. They always occur together; you cannot have one without the other. C H A P T E R 18 72. Convert grams of O2 to moles O2 32 g O2 Step 2. (e) The
change in velocity during this (or any) 1-s interval is 10 m/s. If the Sun were the size of a green pea 110 m away. If people are one day to dart about the universe in the same way we jet about Earth today, their supply of fuel is ensured. The recrystallization of quartzite can be so complete that when struck the
rock splits across the original quartz particles, rather than between them. F I G U R E 1 0 .1 4 A dolphin emits ultrahigh-frequency sound to locate and identify objects in its environment. The Sun would always appear in the same location in the sky. Contrast this with the bottle that is threefourths full, where there is only a small amount of head space
to fill, but plenty of reserve. The common dry-cell battery, which was invented in the 1860s, is still used today, and it is probably the cheapest disposable energy source for flashlights, toys, and the like. If you eat metallic sodium or inhale chlorine gas, you stand a strong chance of dying. Explain to your friends why the poles reverse. 4 An electrically
expansion rate as concrete. Their gravitational fields are no stronger than the original star. What we can say is that in all interactions, whenever work is done, some form of energy increases. (c) A copper penny is smushed into an embossed souvenir.
the vegetables, thus cutting them more effectively. (As Chapter 5 will show, the ball's spin also affects the range.) For heavy projectiles like javelins and the shot, air has less effect on the range in this chapter best shows that a constellation seen in the background of a solar eclipse is one that will be seen six months later in the night
sky? Now that we have seen the different ways that minerals form, we can begin to learn about the combinations of minerals called rock. Because the waveform of music is a multitude of various sine waves, to duplicate sound accurately by radio, tape recorder, or CD player, we should be able to process as large a range of frequencies as possible. A
friend says that a battery provides not a source of constant current, but a source of constant current, but a source of constant current are in the metamorphism of rocks, deeper burial results in higher temperatures. Our Local Supercluster is tied in with an elaborate network of many other superclusters, as shown in Figure 27.37. Investigations of Jupiter tell us that its core is a
solid sphere about 15 times as massive as the entire Earth, and it is composed of iron, nickel, and other minerals. Two principal forms of polyethylene are produced by using different catalysts and reaction conditions. In the absence of air resistance, a snowball thrown vertically upward with a certain initial KE returns to its original level with the same
KE. Of all the physical sciences, astronomy and cosmology are arguably undergoing the most rapid development. Distance = 1 2 * 4 * 52 = 50 m 2. FYI FIGURE 14.5 The familiar bulk properties of a solid, a liquid, and a gas. 3 C H A P T E R 3 Momentum and Energy W e've learned that Galileo's 3. (You'll do this often in chemistry experiments.) 44.
This explains how water has such a high boiling point—the water molecules, being quite polar, are so attracted to one another that a lot of energy is required to separate them from one another into the gaseous phase. This can be compared with concentrations of other solutions. Discuss your reasoning. The steel electrode of the 9-V battery does not
suffice. However, a large number of ion-dipole attractions can act collectively to disrupt ionic bonds. This rule is similar to the rule for the forces between electric charges, in which like charges repel one another and unlike charges attract. The lower polarity of amines also means their boiling points are typically somewhat lower than those of alcohols
of similar formula mass. Why do the downward motion and sudden stop of the hammer tighten the downward motion and sudden stop of the hammer tighten the hammer tighten the shore. Friction occurs
between the road and the tires, which warms up the tires and warms the air within. 8 Electron Waves 12. Where does a clock run slower: at the front end or back end of an accelerating spaceship? Bulbs A and B share the voltage of the parallel branch of the circuit and have half the current of bulb C (assuming resistances are independent of
voltages). 116. What change occurs in its wavelength? This rate of cooling for dry air is called the additive primary colors. Don't bet against it. A quick way to determine whether a reaction might be favorable is to assess whether the reaction leads to an overall dispersal of
energy, which is the same thing as an increase in entropy. Agree; any coil of wire spinning in a magnetic field lines is a generator. 208 PARTONEPHYSICS.comSUMMARYOFTERMS (KNOWLEDGE) Alternating current (ac) An electric
current that repeatedly reverses its direction; the electric charges vibrate about relatively fixed points. Many aldehydes are particularly fragrant. A bar of gold, for example, is gold in color. Like gravity, light grows weaker via the light is 11222 = 14 as bright. Event
horizon * This discussion applies to a nonrotating black hole. 8 Sedimentary Rocks 20. Then there's your friend Alison, fretful about living near a fission power plant. One of the skin-irritating components of poison oak is tetrahydrourushiol: OH OH The long, nonpolar hydrocarbon tail embeds itself in a person's oily skin, where the molecule initiates
an allergic response. Forced vibrations occur when a surface is forced to vibrate. We define each as follows: FIGURE 1.5 An anvil in outer space—beyond the Sun for example—may be weightless, but it still has mass. Tails form by about 1 AU from Sun; tails point away from Sun. Hold a sheet of paper in front of your mouth, as shown in Figure 5.38. At
which of the marked positions A through D does the satellite have the highest speed? 3 6 Paul Ryan tests the hotness of molten lead by dragging his wetted finger through D does the satellite have the highest speed? 3 6 Paul Ryan tests the hotness of molten lead by dragging his wetted finger through D does not ignite until its temperature reaches 233°C.) Tightly rolled paper 36. Reacting 3 g of carbon, C, with 8 g of molecular oxygen, O2, results in 11 g of
carbon dioxide, CO2. g secondary voltage number of secondary turns 36. At one time, mothballs were made of naphthalene. Relative to the Sun, you're at rest; relative to the Sun, you're at rest; relative to the Sun, you're moving at 100,000 km/h. 355: (top) Sue Smith/ Shutterstock 355: (middle, bottom) Paul G. Which two laws of thermodynamics are statements of
what doesn't happen? Hold the ball in front and slightly above yourself. How does this relate to the circular spots that surround Lillian beneath the sunlit tree shown in the photo? So larger atoms—and molecules made of larger
luminosity versus surface temperature for stars. After several days, the canister is resealed and sent to a laboratory that determines the radon level by measuring the amount of radiation emitted by the adsorbed radon. These transmutations result in many protons and neutrons being "sprayed out" into the environment. Interestingly, when you touch
someone, your atoms and those of the other person do not meet. (c) The components of a mixture are not chemically bonded together. A friend claims that bullets fired by some high-powered rifles travel for many meters in a straight-line path before they start to fall. Why doesn't the force of gravity change the speed of a bowling ball as it rolls along a
bowling lane? W ithout gravity, a rock tossed at an angle skyward would follow a straight-line path. The solid phase? When you double the charge on only one of a pair of particles, what effect does this have on the force between them? One ton of ordinary granite contains about 9 g of uranium and 20 g of thorium. 232 PARTONEPHYSICS For
instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Magnetic field The region of magnetic pole or a moving charged particle. Precambrian—first life; stromatolites, bacteria, algae; soft-bodied animals. So why don't all the water droplets in a cloud fall to the
ground? If nitrogen, N2, were pumped into your lungs at high pressure, what would happen to its solubility in your blood? More than one experimental result in modern times has contradicted a lovely theory that, upon further investigation, proved to be wrong. Earth, the blue planet. Hewitt This page intentionally left blank Index A Ablation, in glacial
 mass balance, 610-611 Absolute zero, 147 Acceleration, 27-30, 42-46 free-fall, 28-30, 42-46 free-fall, 28-30, 42-44 gravity and, 778 law of, 41-46, 52 non-free-fall, 44-46 Accumulation, in glacial mass balance, 610-611 Acid(s), 455-470 strength of, 459-462 Acid rain, 466-470 Acid-base reactions. None. (d) none of these 5. III. 11:58 A.M. Bottle 1 is 1/4 full Continued
growth 11:59 A.M. Bottle 1 is 1/2 full and continued doubling lead to enormous num12:00 noon Bottle 1 is full bers. The height of the mug should be at least 1 inch below the height of the mug should be at least
but not so with light. You'll note that although water in the inner container can reach 100°C, it can't boil. This is shown in Figure C.4(b). SAM PLE PROBLEM 1 How many grams of sucrose are in 3 L of an aqueous solution that has a concentration of 2 g of sucrose per liter of solution? Does condensation warm or cool the surrounding air? With no
force, there is no acceleration. If the running speed of Fast Freda doubles, what also doubles is her (a) momentum. Magnetism is relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first paper on special relativistic, as first explained by Albert Einstein when he published his first explained by Albert Einstein when he published his first explained by Albert Einstein when he published his first explained by Albert Einstein when he published his first explained by Albert Einstein when he published his first explained by Albert Einstein when he published his first explained by Albert Einstein when he published his first explained by Albert Einstein when he pub
U C T I O N 219 FIGURE 9.6 Fred Myers shows that the magnetic field of a ceramic magnet penetrates flesh and the plastic coating on a paper clip. At 20C, the solubility of NaNO3 is only 87 g per 100 mL of water. Refraction doesn't change the color of light. When the fluid vaporizes, thermal energy is drawn from objects stored inside the
refrigerator. Boiling and freezing occur at the same time! Frozen bubbles of boiling water are a remarkable sight. Tornadoes evolve from thunderstorms that form in regions of strong vertical wind shear. The earliest designs from the 1950's through 1990's are called the Generation I, II, and III reactors. (c) 60°. A physical property of any material is
its density—its mass per volume. 1.8 The Force of Friction EXPLAIN THIS How much friction acts when you push your desk at constant 23 LEARNING OBJECTIVE Distinguish between static and dynamic equilibrium. Many novel applications of these nano properties are sure to follow. When he is slowly turning with his arms extended, much of the
 angular momentum is due to the distance between the weights and the rotational axis. So light is pulled downward by gravity. LEARNING OBJECTIVE Identify the major attributes of black holes, such as the photon sphere, event horizon, and singularity. This gain of electrons by oxygen and loss of electrons by hydrogen is an energy-releasing process
A penny on its side moving at speed v slides off the horizontal surface of a table a vertical distance y from the floor. You apply a flame to 1 L of water for a certain time and its temperature rises by 2°C. Is there a different answer if their masses are not the same? The same impulse does not mean the same amount of force or the same amount of time;
rather it means the same product of force and time. Monomers have relatively simple structures consisting of anywhere from 4 to 100 atoms per molecular oxygen, O2. The friction force that brings him up to speed is countered by
the same amount of force on the board in the coil, charges in the coil, charges in the coil are set in motion, and voltage is induced in the coil. Rocks may also be drastically stretched or compressed. How frequently a vibration occurs is described by its
bonds. If you place the paper against the lower surface of the raised book and again drop them at the same time, it will be no surprise that they hit the surface below at the same time. The ammonia behaves better as a base than as an acid, which means that it contributes very, very few hydrogen ions. Feldspar (Mineral) + = Quartz (Mineral) +
Granite (Rock) Hornblende (Mineral) Metamorphic rocks are formed from older, preexisting rocks (igneous, sedimentary, or metamorphic) that were transformed in Earth's interior by high temperature, high pressure, or both—without melting. Why don't nuclear fusion reactions occur on the outer layers of stars? CHAPTER 20 R O CK S A N D M I N
E R A L S 527 Minerals that have no planar alignment of bonds, like quartz, cannot display cleavage and always fracture. What happens in a barometer is similar to what happens when you drink through a straw. FIGURE 26.21 Cyclonic disturbances on Neptune in 1989 produced a great dark spot, which was even larger than Earth and similar to
Jupiter's Great Red Spot. Indeed, many of the great advances in the life sciences today, such as genetic engineering, are applications of some very exotic chemistry. Would the springs inside a bathroom scale be more compressed or less compressed if you weighed yourself in an elevator that accelerated upward? For providing several wonderful Earth
science photos, we thank Dean Baird (CPS Lab Manual author). Homogeneous mixtures have the same composition distinguished. Which structure of Figure 19.7 do you suppose has more possible conformations: butane or 2-butene? When you pass the compass from their bottoms to their tops, you can easily identify their poles. Which ball goes
farther? How does the charge of one electron compare with the charge of another electron? No current is lost and no heat is generated in superconductivity. What condition is necessary for a sustained flow of electric charge through a conducting medium? State an exception to the claim that all substances expand when heated. The powerful bond
that unities the oxygen and silicon ions is akin to the cement that holds Earth's crust together. Both series and parallel connections have their own distinctive characteristics. He extended Galileo's work and developed the three fundamental laws of motion. (Isopropyl alcohol is very toxic if ingested. T H I N K A N D S O L V E (M AT H E M AT I C A L As a connection of the cement that holds Earth's crust together. Both series and parallel connections have their own distinctive characteristics.
PPLICATION) 31. Density The amount of matter per unit volume: mass Density = volume Weight density is expressed as weight per unit volume. Pure is understood to be a relative term. For example, an astronaut taking a two-year round trip into space at high speeds could come back to find that Earth has aged 2000 years! For now, however,
 we turn to something even more mysterious, which is the potential presence of a form of matter completely invisible to our sight and sense of touch. The diaphragm in one's body reduces lung pressure to permit breathing, but this limit is strained when nearly 1 m below the water surface. These chains tend to be straight, so they pack well together
(like wooden matches in a box). What percentage of galaxies were created during cosmic inflation? C H A P T E R 14 14.1 Chemistry: The Central Science EXPLAIN THIS W How has chemistry influenced our modern lifestyles? Throw away the gamma emitter because gamma rays penetrate your body from any of these locations. Solar power via low-
cost thin solar films used in building materials, including roofing and glass, is changing the way we produce and distribute energy. Equation d best describes the reacting chemical, (c) chemical to the net force acting on a falling 1-kg
ball if it encounters 2 N of air resistance? Heat transfer by conduction through the vacuum is impossible. Rank in order of increasing size: (a) solar system, (b) Local Group, and (c) galaxy. Using your knowledge of chemistry, explain why these fears have no basis and how distilled water is in fact very good for drinking. So thin, dense oceanic crust sits
lower in the mantle than thicker, less-dense continental crust. How many can occupy the second shell? Many of these additional 463 464 PA R T T W O CH E M I S T RY hydronium ions neutralize hydroxide ions, which then become fewer. Multiple bonds higher than these, such as the quadruple covalent bond, are not commonly observed. Okay, a
slow! FYI Remember that the shell model is not to be interpreted as an actual representation of the atom's physical structure. 749: NASA, ESA, J. Add several tablespoons of table salt to one cup and stir. One of the kids, however, tends only to take jelly beans and rarely gives one away. Which of Newton's laws focuses on inertia, which on acceleration
and which on action-reaction? Both the overall density of Earth and the speed with which seismic waves travel through the core suggest that the core is composed of iron, a material that is much denser than the silicate rocks that make up the mantle. Therefore, from F = G(m_1m_2/d_2), where m_1 is the mass of Earth, g_1 = g_1 = g_1.
bond energy. A glider has a very large wing area relative to its weight, so it does not have to be going very fast for sufficient lift. Is any star bright enough for us to see on a sunny day? (a) Middle clouds, (b) high clouds, (c) low clouds, (d) low clouds, (e) low clouds, (e) low clouds, (e) low clouds, (f) low clouds, (g) low cl
 and then moves over the coastal regions. Cave dripstones, such as stalactites and stalagmites, provide a great example of calcium carbonate precipitating inorganically from dripping water (Figure 20.14). At an acidic pH, which structure is more likely? If a flight mechanic drops a box of tools from a highflying jumbo jet, the box crashes to Earth.
for aqueous solution. It is round because of gravitation. Notice that we are talking about what we recently learned—that no change in motion occurs when E = 0. At times in Earth's history, shallow seas covered the continental land, allowing for the deposition of carbonate rocks. This is the time it takes for half of an original quantity of an element to
decay. This classification scheme is shown in Figure 16.7. Because atoms and molecules are so small, it is impractical to prepare a sample that is, truly pure—that is
Nimbostratus Warm front Altostratus Stratus Cool air mass F I G U R E 2 5 .1 3 A warm front occurs when a warm air mass moves into a cold air mass. There are as many planes of vibration as the vibrating electrons producing them. The active ingredient of most mosquito repellents is an amide whose chemical name is N,N-diethyl-m-toluamide but is
commercially known as DEET, shown in Figure 19.22. When the bottle is opened, the "head" of highly pressurized carbon dioxide gas escapes. 6 Fast- Moving Projectiles—Satellites 4. Some collisions form new stars. Thus, marble can vary in color from pink to gray, green, or even black. Big as the Sun is, the solar system is mostly empty space. To
 understand the relation between pressure and density, think of the molecules of air (primarily nitrogen and oxygen) inside the tire. Mass and energy are two sides of the same coin, as stated in his celebrated equation E = mc 2. Would the springs inside a bathroom scale be more compressed or less compressed if you weighed yourself in an elevator
that moved upward at constant velocity? The rate of cooling of an object—whether by conduction, convection, or radiation—is approximately proportional to the temperature difference ©T between the object and its surroundings: Rate of cooling & ©T This is known as Newton's law of cooling. Can something have energy without having momentum?
Magnetic containers hold high-temperature plasmas. The fourth and fifth shells can each hold 18 electrons, and the sixth and seventh shells can each hold 32 electrons.* These numbers match the number of elements in each period (horizontal row) of the periodic table. To view this full Moon you need to be on the nighttime side of Earth, at sunset
 "wanderers" by ancient astronomers, appear to migrate across the fixed backdrop of the celestial sphere. This is the fate of bits of rock and other meteorites that enter Earth's atmosphere and burn up, appearing as "falling stars." That is why satellites, such as the space shuttles, are launched to altitudes of 150 kilometers or more—to be above almost
all of the atmosphere and to be nearly free of air resistance. Suppose you set up a standing wave of three segments, as shown in Figure 10.28c. Air resistance is not really negligible for such a high drop, so the heavier ball does strike O D D - N U M B E R E D S O LU T I O N S the ground first (see Figure 2.10). Small, rounded particles indicate a
 longer travel time and a longer distance. You can add heat without raising the temperature when the substance is undergoing a change of phase. They scavenge the desert surface for the corpses of creatures that did not find cover in time, touching the hot sand as little as possible while often sprinting on four legs with two held high in the air.
Mixtures can be separated into their components by taking advantage of differences in the chemical properties of the components. We can see that the magnetic field strength is greater at the poles. At the nuclear level, if one oxygen and two hydrogen were fused, what element would be produced? I'm told Earth would look like a large dark orb
surrounded by a ring of brilliant red as the light from the hidden Sun refracts through Earth's atmosphere—like a zillion sunsets all at once! Hmm. Explain why, for these three substances, the solubility in 20°C water goes down as the molecules get larger but the boiling point goes up. The Doppler effect is evident when you hear the changing pitch of
an ambulance or fire-engine siren. Sucrose stirred into water loses its crystalline Aqueous solution of sucrose form. 3 m from it? Turpentine is good for removing the grime left on hands after such activities as changing a car's motor oil. If both are halved? Ammonia, NH3, is the weaker base, indicated by the relatively few ions in the solution on the
left. What law of physics is inferred when we say you cannot touch without being touched? The small chunks have more combined surface area of gravel is greater than the surface area of a boulder of the same mass). This and other reasons suggest that the core is composed of
iron and smaller amounts of nickel, the most abundant of the heavier elements. Every student radiates about the same amount of heat as a 100-W incandescent bulb. A monkey hangs stationary at the end of a vertical vine. Once he knew both the weight and volume, he could calculate the density. LEARNING OBJECTIVE Discuss the significance of
heteroatoms in organic compounds. Which of the laws of thermodynamics says what doesn't happen? The simple model of Figure 11.53c represents unpolarized light. If the momentum of an object changes, then either
the mass or the velocity or both change. What happens to Earth's crust in a zone of reverse faulting? (c) resonance. As the answers were found, they became part of what is now called science. Explain why some of your classmates confuse the two, and give some examples that clear up the confusion. 24 PA R T O N E P H Y S I CS F I G U R E 1.16
Friction results from the mutual contact of irregularities in the surfaces of sliding objects. The relative movement of a strikeslip fault is horizontal. When will the gravitational force between you and the Sun be greater: today at noon or tomorrow at midnight? We can compare the gases in a magma to gases in a bottle of carbonated soda. Fusing heavy
nuclei (which is the way the heavy transuranic elements are made) costs energy. This first thermonuclear bomb, a hydrogen bomb, was detonated in 1 2 4 H 13 H He n 17.6 MeV 1952. (b) Which remains the same for a 10-\(\frac{1}{4}\) and a 20-\(\frac{1}{4}\) resistor connected in a parallel circuit? Since 100 tons of water are displaced by a 100-ton floating ship, the buoyant
force on the ship is 100 tons. CHECKPOINT Is the Bohr model of the atom a physical model or a conceptual model? The high humidity in this part of the world favors the development of cumulus clouds and afternoon thunderstorms. B 67. (b) The saturated hydrocarbon has more hydrogen atoms. When nitrogen and fluorine combine to form a
molecule, the most likely chemical formula is (a) N3F. Luminosity is usually expressed relative to the Sun's luminosity, which is noted LSun. What is important is the large magnitude of k. An atom on the Sun, therefore, should emit light of a lower frequency (slower vibration) than light emitted by the same atom on Earth. For example, a golf club that
strikes a ball exerts zero force on the ball until it comes in contact; then the force increases rapidly as the ball is distorted (Figure 3.3). (b) A scintillation counter detects incoming radiation by flashes of light that are produced when charged particles or gamma rays pass through it. The motions in the mantle, however, are not uniform. To test which
you favor, hold a finger up at arm's length. Show that the mass of the block of ice can be no more than 80 g. Consider ethane, C2H6, and ethanol, C2H6O, which differ from each other by only a single oxygen atom. In the U.S. we speak of low-calorie foods and drinks. b, 4. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 111. (b) The
activation energy of both these reactions must be very high. How much energy is given to each coulomb of charge passing through a 6-V battery? The mass of a single gold atom. This coil, which acts as an electromagnet, is located near a permanent magnet. Because rock is
an elastic material, rocks also return to their original shape after stress is removed—unless the elastic limit is exceeded. Kinetic energy of random molecular motion is related to temperature; potential energies of electric charges account for voltage; and kinetic and potential energies of vibrating air define sound intensity. What effect does Earth's
magnetic field have on the intensity of cosmic rays striking Earth's surface? Distinguish between velocity and acceleration. FIGURE 1.4 A ball rolling down an incline tends to roll up to its initial height. A pair of toy cart wheels are rolled obliquely from a smooth surface onto two plots of grass, a rectangular plot and a triangular plot, as shown. The
cold air flows beneath the warm conveyor, picking up moisture from the evaporation of raindrops that fall through it from the warmer air above. This descending air is dry because most of its moisture was removed in the form of clouds and precipitation on the windward (upslope) side of the mountain. a, 9. Does such a process yield energy or cost
energy? How much energy is required to tear an electron away from an atom varies for different substances. The character of a polar covalent bond falls between these two extremes. When the room gets too warm, the coil bends toward the iron side, which breaks the electrical circuit and turns off To furnace the heater. This positive charge can
cause the fluorine atom to become attracted to the unpaired valence electron of a neighboring fluorine atom. In other words, motion requires a reference frame (an observer, origin, and axes). In Part 1 of this book are Plug and Chug problems, very simple one-step "plug-ins" to familiarize you with the formulas of the chapter. (a) (b) (c) FIGURE 20.34
As compressive forces squeeze platy and sheet-structured minerals, the grains align themselves perpendicular to the main direction of force. There are eight known planets. In some owls, one ear is also higher than the other, further sharpening their prey-locating ability. Entropy will have won supreme victory. What are the three ways in which
voltage can be induced in a loop of wire? Therefore a 12-V input will be stepped up to 6 * 12 V = 72 V. We simply divide the amount of energy in Chapter 3, we learned that an object has gravitational potential energy because of its location in a gravitational field. To many cultures, including
the African Bushmen and Masai, the constellations provided a guide for planting and harvesting crops because they were seen to move in the sky in concert with the seasons. This global warming process is very nice, for Earth would be a frigid - 18°C otherwise. Over time, this continuous process moves the entire dune. Isn't there a contradiction
here? The speed of Earth relative to the Sun is not the speed of the wall relative to you. What is the half-life of uranium-238? If Ken starts pulling on the cord, will he pull Joanne toward him, or will he pull Joanne toward him, or will he pull joanne? Yet many people choose to smoke cigarettes in spite of the fact that 2 million people die every year from smoking-related
diseases. * A cubic meter is a sizable volume and contains a million cubic centimeters, so there are a million grams of water in a cubic meter (or, equivalently, a thousand kilograms of water in a cubic meter is simultaneously
destroyed in the deep ocean trenches near the edges of some continents. Remember that for an object brought to rest, the impulse is the same no matter how it is stopped. To examine this new "gravity" due to acceleration due to gravity, discussed in Chapter 4), Einstein considered the consequence of releasing two balls—
say, one of wood and the other of lead. Show that the nearest star, Alpha Centauri (4.4 light-years away), would be about 30,000 km distant. Like the compass needle in Figure 9.4, domains in the unmagnetized piece of iron are induced into alignment by the magnetic field of the magnet. The total weight of the balloon, including its load and the hot air
in it, is 20,000 N. The masses of elements shown in the periodic table are relative masses. (a) Rising magma uplifts continental crust, causing the surface to crack. The cooking time will be no different for vigorously boiling water and gently boiling water because both have the same temperature. Recall Newton's second law: a = F m m Let F represent
both the action and reaction forces, the mass of the cannon and the ultraviolet light of direct sunlight damage the eyes. resulting polarity of this molecule is zero. Two teams of eight horses each were unable to pull the
Magdeburg hemispheres apart (see Figure 5.20). Without catalysts, the price of gasoline would be much higher, as would be much higher hi
hold the mirror close or at arm's length. Comment on an airline passenger who takes a flash photo of a city below at nighttime from a high-flying plane. Both processes direct a burst of high-pressure air to the listener. Such a speed is called the escape speed because the satellite escapes the influence of Earth. Electric potential energy a
charge possesses by virtue of its location in an electric field. LINEARANDROTATIONA-5 of "tail-end Charlie" is evidence of this greater speed. We will learn in Chapter 5 that the curved surface of a wing is an airfoil, which enhances the lifting force. It was his experiments with prisms that first made him famous. Each
mineral type has its own melting point, which results in magmas of different compositions. A starburst's high rate of star formation is often the result of some violent disturbance, such as a collision between two galaxies. Our best bet is to stop producing CFCs and hope that we haven't already caused too much damage. Tune into some 40,000 years
ago and you are able to witness the migration of humans into the Australian subcontinent. (d) has such a strong electronegativity. After our Sun burns its supply of hydrogen, it will become a (a) white dwarf. When it is subjected to even more pressure and heat, coal can transform into the metamorphic rock called anthracite, which is the highest grade
of coal. An electroscope is a simple device consisting of a metal ball that is attached by a conductor to two thin leaves of metal foil protected from air disturbances in a jar, as shown. Then we get Pressure = weight density * depth For the total pressure
we should add to this equation the pressure due to the atmosphere on the surface of the liquid. The result is reduced acceleration. We see the
constellations as distinct groups of stars. The decrease of fluid pressure with increasing speed may at first seem surprising, particularly if you fail to distinguish between the pressure with its flow. If a space with less pressure is provided, gas flows from the
region of higher pressure to the one of lower pressure. CHECKPOINT What is the molar mass of water (formula mass g 18 amu)? Consider a circuit with a main wire that branches into two other wires. The work done equals the force required to move it upward multiplied by the vertical distance it is moved (remember W = Fd ). Each packet is called
a quantum, also known as a photon. When we refer to the "solubility" of a substance—in this case, water. Electrons can be forced into vibration by the vibratio
temperature of the universe. According to the equation for gravitational force, what happens to the force between two bodies if the mass of one of the bodies is doubled? An object that has equal numbers of electrons and protons has no net electric charge. (c) A, B, C, D. Discuss whether a stick of dynamite contains force. As more and more bulbs are
connected in series to a flashlight battery, what happens to the brightness of each bulb? Besides, the conversion between Celsius and Fahrenheit temperatures is closely approximated in the side-by-side scales of Figure 6.2.* Temperatures is closely approximated in the side-by-side scales of Figure 6.2.*
dot structure for an atom or ion is sometimes called a Lewis dot symbol, while the electron-dot structure of a molecule or polyatomic ion is sometimes called a Lewis structure. To throw a ball, do you exert an impulse on it? Hanging wall block (a) Footwall block (b) Stress in rock also occurs because of tension. You can make a simple 1.5-V cell by
placing a strip of copper and a strip of copper and a strip of salt water. The skateboard slows. The idea of a moving Earth was much debated. How do the pulses differ? 20.8 Sedimentary Rocks 23. How can a layer of altostratus clouds? Northwest? (b) distances. The vacuum also prevents heat loss through the walls by
convection, because there is no air between the walls. Quality The characteristic timbre of a musical sound, which is governed by the number and relative intensities of partial tones. (a) pressure and water content (b) temperature and water content (c) temperature and water content (d) silica content and water content (e) temperature and pressure (f) temperature and water content (h) temperature and water (h) temperature and (h) temperature and (h) temperature and (h) temperatu
and Earth's Interior I f it were possible to dig a hole straight 21. LIGNITE metamorphism 3. Notice also how the sensitivity of your hearing improves when you cup your hands behind your ears. Hydrogen chloride is a strong acid because the chloride is a strong 
as strong as the chemical bonds holdmolecules, for example, is only about 20 ing the hydrogen and oxygen atoms together in the water molecule. In Figure B.7, F represents the force applied by the man. For example, 1 rad of alpha particles has the same biological effect as 10 rads of beta particles.** We call both of these dosages 10 rems: Particle
alpha beta Radiation Dosage 1 rad 10 rad Factor * * 10 1 Health Effect = 10 rems 10 rems * This unit is named for the discoverer of X-rays, Wilhelm Roentgen. Amount of water in air = 0.4 9 g>m3 Amount of water in air = (9 g/m3)(0.4) = 3.6 g/m3. The spiral bands of
cumulonimbus clouds give the hurricane its familiar appearance (Figure 25.20). Firstperiod elements (b) 8 8 32 32 18 18 (c) A series of seven such concentric shells accounts for the seven periodic table. 105 FIGURE 4.25 Earth's curvature (not to scale). (The surrounding air, on the other hand, would be cooled. This is an example of
applied research, because the primary goal was to develop a useful commodity. Which of the three boxes on the right—(a), (b), or (c)—best represents this material upon the addition of heat? Which forms the positive ions: the acid or the base? 100. The axis that is reversed, as shown to the right, is her front-and-back axis. The outward thermonuclear
expansion and inward gravitational contraction produce an equilibrium that accounts for the star's size. The change in length ©L of a material is given by ©L = La©T. Both forces are equal and oppositely directed. Hot objects contain thermal energy, not heat. Two hydrogen atoms, for example, covalently bond to form a hydrogen molecule, H2, as
shown in Figure 15.17. A 1-carat diamond, for example, has a mass of 0.20 g. An ET question would be fairly difficult for the student to answer without having read the chapter section. Why does relative humidity increase at night? Paleomagnetism revealed that, over the past 500 million years, the position of the magnetic north pole had apparently
wandered throughout the world. Assuming the ratio of C-14 to C-12 was the same when the ax was made, the ax handle is as old as two half-lives of C-14, or about 11,460 years old. Air resistance depends primarily on two things: speed and frontal area. Deposits of these natural metals, also known as native metals, are quite rare. Each helium atom
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has two electrons, both of which are also within the first shell, which is thus filled to its maximum capacity. (c) NF4. The Moon, however, orbits Earth in an eastward direction, which explains why the Moon always appears east of where it was 24 hours earlier. net momentumbefore collision = net momentumafter collision This is true no matter how
the objects might be moving before they collide. At higher speed the aircraft is supersonic. (d) all of these 6 C H A P T E R 6 Thermal Energy and Thermodynamics W hat's the difference between 6. So the spring tide cycle consists of higher than-average high tides followed by lower-than-average low tides (the best time for digging clams). Do the
photos support or refute the claim that they were taken on the same day? (d) increased convection currents. The Doppler effect holds for all types of waves. With only one ear you would have no idea (and in an emergency might not know which way to move). In fact, it is an important way of telling whether a wave is transverse or longitudinal. Then
you begin to fall, gaining speed at exactly the same rate, g. Coulomb The SI unit of electric charge. Some electric field configurations are shown in Figure 8.11. Great things will no doubt be achieved through nanotechnology, but as a complement to the great things achieved through novel
chemical reactions. The gravitational potential energy, mgh, is relative to that level and depends only on mg and h. 184 PA R T O N E P H Y S I CS 71. Interestingly enough, when the ship is Empty ship Loaded ship FIGURE 21.8 Isostasy: The vertical position
of the crust is stable when the gravitational and buoyant forces balance. Because average speed is the entire distance covered divided by the total time of travel, it doesn't indicate the various instantaneous speeds that may have occurred along the way. Its next scheduled return is in 2061. The Moon is even farther away and has a period of 27.3 days
Calculate the quantity of heat needed to melt a 200-g block of ice at 0°C. Uranium-235 releases an average of 2.5 neutrons per fission, while plutonium-239 releases an average of 2.7 neutrons per fission, while plutonium-230 releases an average of 2.7 neutrons per fission. Hence the name for this area:
the mat by relaxing his muscles and spreading the impact into a series of smaller ones as his foot, knee, hip, ribs, and shoulder successively hit the mat. VIDEO: Mixtures Can Be Separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated by Physical Means Chemists have devised many ingenious ways of separated ways of separated ways of separated ways of separated ways are separated which was a separated which was a separated ways of 
high pressure to keep it at a high temperature without boiling. 17 Galileo and William Shakespeare were born in the electrons of the outermost occupied shell in any atom are directly exposed to the external environment and are the first to
interact with other atoms. Utterly huge. When should one be favored over the other? Interestingly, the total mass of our atmosphere is only about 5 * 1015 metric tons. (a) Show that the height of the bridge is 12 gt 2. Even the ice at the planet's poles consists primarily of carbon dioxide. Radio waves can't vibrating electrons and the frequency of the
wave produced are the same. A liquid absorbs energy when it changes into a gas; when a liquid changes into a solid, it gives off energy. To explain atmospheric pressure, we should consider compressible bricks, like foam rubber. But Hubble took his research a step further and discovered something even more amazing. At what point in its motion is
the KE of a pendulum bob at a maximum? What kind of weathering is imposed on a rock when it is smashed into small pieces? Part of Earth's mantle is rigid, and part is hot enough to flow as a plastic solid. Hewitt 422: (top left) Pearson Education/Pearson Science 422: (top right) Paul G. Galena,
a lead sulfide ore, is used in wireless communication systems, and the sulfide chalcopyrite is an important copper ore. When we apply physics, chemistry, and geology to other planets and to the stars, we are speaking about astronomy. Actually, the more basic concept of fields is at the root of both voltages and currents. But this contradicted the much
longer time difference expected by the followers of Aristotle. Another way is to stroke the material with a magnet. Air F I G U R E 11. These two electrons must have come from the single manganese ion to which it is bound. Well-shaped crystals are rare in nature because minerals typically grow in cramped spaces. CHECKPOINT Why does the
magnesium atom tend to form the 2 h ion? If you place a metal ring in a region where a magnetic field is rapidly alternating, the ring may become hot to your touch. In Figure 3.7, how does the force that Cassy exerts on the bricks compare with the force exerted on her hand? Glacial deposits are poorly sorted and very angular because they are
trapped in ice during transport. The "shell," for example, is a metaphor that helps us visualize an invisible reality. But who will watch over these nanotech companies to make sure that greed does not take priority over safety? Toward the equator the plane of our solar O D D - N U M B E R E D S O LU T I O N S system appears perpendicular to the
horizon. ** An elastic substance is "springy," has resilience, and can transmit energy with little loss. If both masses double, the force is four times as much. Instead, you conclude that molecules exist because they offer the best explanation for what you observe. These numbers are called coefficients, and they represent numbers of individual atoms and
molecules. A lead nucleus is so massive that it scarcely rebounds at all. (As discussed in Section 12.3, one atomic mass of a substance is the sum of the elements in its chemical formula. There's a little more than 6 radians in a full rotation (2p radians, to be exact). What are
some differences between corrosion and combustion? The Tg of polyethylene is a chilly -125°C, which is why polyethylene food wrap is flexible at ambient temperatures. 8 Molecular Attractions distinct cubic shape? They discovered that voltage is caused, or induced, by the relative motion between a wire and a magnetic field. H2 N H2N NH2 NH2
Putrescine (1,4-butanediamine) F I G U R E 1 9 .1 6 Cadaverine (1,5-pentanediamine) Low-formula-mass amines such as these tend to have offensive odors. The dipole-induced dipole attraction is weaker and involves a permanent dipole and a temporary one. Electric energy from a fossil-fuel or nuclear power plant Metal alloy Roasting carbohydrates
fats, proteins, and vitamins Natural gas laced with odoriferous sulfur compounds Fertilizer-grown vegetables Industries in the United States employ about 900,000 chemists. (d) decreases and its acceleration increases. (b) The tin ion, Sn2 +, is reduced, while the silver, Ag, is oxidized. Southwest? Is it also possible for two carbon atoms connected by
a double bond to rotate relative to each other? After it cools, clean it off in running water. Compound A material in which allows the Andes to rise upward more rapidly than wind and rain can erode them. This makes sense:
because twice as much mass is moving after the collision, the velocity must be half as much as the velocity before the collision. A dipole is an uneven distribution of electrons in a bond caused by a difference in electronegativity between two atoms. Destructive Constructive Constructive Standing Waves Another fascinating effect of
interference is standing waves. Outer planets The four planets orbiting beyond 2 AU of the Sun, including Jupiter, Saturn, Uranus, and Neptune—all gaseous and known as the jovian planets orbiting beyond 2 AU of the Sun, including Jupiter, Saturn, Uranus, and Neptune—all gaseous and known as the jovian planets. If this happens quickly, the reaction rate is high. Why doesn't the water run out? See Chapter 27 for more on where the various constellations are located in the
night sky. The heavier water sinks to form a layer at the bottom and the less-dense oil rises to form a layer at the difference between a saturated hydrocarbon and an unsaturated hydrocarbon? Sound cannot
travel in a vacuum because there is nothing to compress and expand. Is the sucrose destroyed? Is this cup melting or dissolving? In sunlight, it is warmer than the white square. A projectile is launched vertically at 100 m/s. impure, 399-400 separation of, 398-399 solutions, 401-405. Appliances such as irons, stoves, washing machines, and dryers are
connected with these three wires. 2 Transparent and Opaque Materials 11. The term supernatural literally means "above nature." Science works within nature, not above it. Yet there are several elements below uranium in the table that have equally short halflives but do exist in appreciable amounts in nature. We, in turn, eat the plants, or
planteating animals, to support life-sustaining chemical reactions within ourselves. (a) A hole is sunk several kilometers into dry granite. Compare their units of measurement. Fifty grams of hot water at 80°C. Blue illumination (the complementary color of yellow) will produce black. Discuss why
a motor also tends to act like a generator. The transformer actually transfers energy from one coil to the other. 62 PARTONE PHYSICS LEARNING OBJECTIVE Describe the relationship between impulse and momentum. A common inactive ingredient in products such as sunscreen lotions and shampoo is triethylamine, also known as TEA. Inflate
the balloon to its full size and tie it shut. If you submerge these life preservers in the water, upon which is the buoyant force greater? If you know that 102 is equal to 100, then you'll understand that the logarithm of 100 also is 2. The first astronaut throws the second astronaut toward the third one and the game begins. When asked how he was able
to make so many discoveries, Newton replied that he solved his problems by continually thinking very long and hard about them—and not by sudden insight. So our observable universe is huge. Because certain minerals align themselves with the magnetic field when a rock is formed, many rocks have a preserved imprint of changes in Earth's
magnetism over geologic time. Halite weathers first because it has a high solubility (precipitates last in an evaporating body of water) and so dissolves easily in a humid environment. 43 If the gecko's foot is so sticky, how does the gecko keep its feet clean? The combination of energy and matter makes up the universe: matter is substance, and energy
is the mover of substance. But that never happened, and so the Kuiper belt is another zone of failed planet formation. Ideas about the minds of succeeding generations. Each atom thus achieves a filled valence shell. To reduce "information overload" we will not
treat inductance in this book. EXPLAIN THIS 97 It's widely assumed that when Earth was no longer considered special. Why doesn't the solid inner core melt? Note how the coefficients of the balanced chemical equation can be
conveniently interpreted HOWCHEMICALSCIENCE 16 amu), reacts with oxygen, O2, in the reaction below? FIGURING PHYSICAL SCIENCE 16 amu), reacts with oxygen, O2, in the reaction below? FIGURING PHYSICAL SCIENCE 16 amu)
impossible; this is the hanging wall block. 3.3 Conservation of Momentum What stays the same when a pool ball stops after hitting another ball at rest? Why are your answers the same or different? Where does this energy come from? (b) Like poles are nearest to each other. But he can walk as safely with dry feet. How might warmer oceans
accelerate global warming? We could stack microscope and never "see" an atom. The hydrocarbon polyethylene contains hundreds of carbon and hydrogen atoms per molecule. 5 Amines and Alkaloids 19. If so, does it exert as much force on the magnet exerts on it? We can express this equation formally, then let
the expressed terms lead to a solution: ©T1 doesn't equal ©T2 as in Sample Problem 1 because of different masses of water. 36. Blue-green light has a frequency of about 6 * 1014 Hz. Using the relationship c = f l, show that its wavelength in air is 5 * 10-7 m. The energy required for this initial breaking of bonds can be viewed as an energy barrier.
14.6 Naming Compounds EXPLAIN THIS A What information is found within the name of a compound? Clouds are semitransparent to ultraviolet light, which is why you can get a sunburn on a cloudy day. Can you see how this relates to radioactive half-life? The next simplest meter is a compass in a coil of wires (Figure 9.18). By what factor is its
kinetic energy changed? When the temperature drops below a certain threshold, called the dew point temperature, the air becomes saturated—relative humidity is 100%—and condensation dominates. Reacts with vinegar to form carbon dioxide and water, absorbing heat during the reaction. (A small amount of shorter wavelengths do get through.)
When Polaroid filters are used in pairs like this, the first one is called the polarizer and the second one is called the more empty your fridge, the more cold air is swapped with warm air. 2 3 A wide-
angle photograph of the Milky Way, which appears as a north-south cloudlike band of light. When moving air strikes the underside of an airplane wing, the force of air impact against the wing may be represented by a single vector perpendicular to the plane of the wing (Figure B.10). v=0 100 N v=0 120 N v=1 m/s 130 N 15 N A B C CHAPTER 2 56
It's okay not to know the answers to such religious questions. FIGURE 18.29 Carbon nanofibers consist of nearsubmicroscopic tubes of carbon atoms. In ocean water it is the water that evaporates; the salt is left behind. Now consider an air parcel that is forced upward. It is also the most tightly bound nucleus; more energy per nucleon is required to
separate nucleons from its nucleus than from any other nucleus. When a vehicle makes a turn, even if its speed does not change, it is accelerating. The fluorines in nitrogen trifluoride, NF3, have the effect of pulling the lone-pair electrons closer to the nitrogen. An immersed body is buoyed up by a force equal to the weight of the fluid displaced.
Because of these physical properties, a surgical patient can be brought in and out of anesthesia (a state of unconsciousness) simply by regulating the gases breathed. Why can't a diver simply breathe through a hose that extends to the surface? At this tiny separation distance, the strong nuclear force overcomes the electric force, and the protons stay
together. FIGURE 13.28 Work is required to pull a nucleon from an atomic nucleus. As described in the box on page 753, tidal forces would rip you apart before you fall into a regular-sized black hole. A certain radar installation that is used to track airplanes transmits electromagnetic radiation with a wavelength of 3.0 cm. For example, what
acceleration is produced by a force of 2000 N applied to a 1000-kg automobile? The important component is that which we label K, and the other component is perpendicular to the keel, which we label T. A vibration is a wiggle in time. Almost immediately, people began harnessing the electromagnetic force for useful
purposes—with great sensitivity in electric meters and with great force in electric motors. A, C, B. T H I N K A N D S O L V E ( M AT H E M AT I C A L A P P L I C AT I O N ) 50. (Hint: Let the terms in the equation for gravitational force guide your thinking.)
appearance is the result of the formation of a new material that has its own unique set of physical properties. Zn 1 H 12 Na Mg 19 K 25 27 29 5 6 7 8 9 10 B C N O F Ne 18 13 14 15 16 17 Al Si P S Cl Ar 31 32 33 34 35 22 23 24 Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 41 42 21 26 28 30 36 38 39 40 52 53 54 Y Zr Nb Mo Tc Ru Rh Pd Ag
Cd In Sn Sb Te I Xe 56 57 72 85 86 55 Hg 20 2 He Rb Sr 37 Mercury is a liquid metal at room temperature. The largest region of Earth's interior is the solid mantle, which is composed of low-silica-content igneous rocks. You can "quantize" your whistle by whistling down a long tube, such as the tube from a roll of wrapping paper. 1 km CHAP TER 26
THE SOL AR SYSTEM 721 Uranus Uranus (pronounced "YUR-uh-nus," accent on the first syllable) is twice as far from Earth as Saturn is, and it can barely be seen with the naked eye. Therefore, the amount of energy associated with the charged balloon is very, very small. What happens to a reducing agent as it reduces? Because of compaction and
how easily calcium carbonate dissolves, the original textures and structures of the seashells are often obliterated. Hewitt 127: (left, right) Shutterstock 129: Public domain via Wikipedia 131: Paul G. FYI What is the logarithm of 100,000? Go to it—we live in a time of rapid and fascinating scientific discovery! For instructor-assigned homework, go to
www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Fact A phenomenon about which competent observers who have made a series of observations are in agreement. We'll see in Chapter 4 that hang time depends only on the jumper's vertical speed at launch. Repeat this process until all the coins have been removed. Distance
1 2 * 9.8 * 42 = 78.4 m Notice that the units of measurement when multiplied give the proper units of meters for distance: d = 1 2 * 9.8 m * 16 = 78.4 m Circular Motion inear speed is what we have been calling simply speed—the distance travL eled in meters or kilometers per unit of time. Radiometric dating A method for calculating the age of
geologic materials based on the nuclear decay of naturally occurring radioactive isotopes. Of course, you wouldn't be able to see this wall either. An ideal way to view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as was shown in Figure 26.4. Alternatively, you can view the partial solar eclipse is to focus the light of the eclipse onto a white surface, as well as the eclipse of the ecl
which casts pinhole images of the Sun onto the ground, as shown in Figure 26.32. Knowing that k is 9 * 109 N. As calcium and magnesium ions pass over the resin, the ions displace the sodium ions and thereby become bound to the resin
Away from their profession, scientists are inherently no more honest or ethical than most other people. 559 The density of rocks at Earth's surface is 2.793.0 g/cm 3, whereas the average density of rocks at Earth's surface is 2.793.0 g/cm 3, whereas the average density of Earth as a whole is 5.5 g/cm 3. (c) intermediate mass. CHECKPOINT We eat organic chemicals daily. How far below? What is the evidence for believing
our Sun is a relatively young star in the universe? When dropped, the crumpled foil falls faster only because it encounters less air resistance than the uncrumpled foil. His findings expanded upon and substantiated other disNorth America coveries and emerging ideas. It gives up some of its kinetic energy to the slower ones. This is nothing to write
home about. (b) What is its velocity 1 s before it reaches its highest point? How does the speed of light that emerges from a pane of glass compare with the speed of light incident on the glass? When such a massive star contracts after its giant or supergiant phase, more heat is generated than in the contraction of a small star. 1 mi = 1.6093440 km
liter = 103 \text{ cm} 3 = 10-3 \text{ m} 3 Pressure 1 Pa = 1 \text{ N/m} 2 1 atm = 1.013 * 105 Pa 1 lb/in.2 = 6895 Pa Time 1 year = 36514 day = 3.1558 * 107 s 1 d = 86,400 \text{ s} 1 h = 3600 \text{ s} Energy and Power 1 cal = 4.187 \text{ J} 1 kWh = 3.60 * 106 \text{ J} 1 eV = 1.602 * 10-19 \text{ J} 1 u = 931.5 \text{ MeV} 1 hp = 746 \text{ W} Mass 1 kg = 1000 \text{ g} 1 kg weighs about 2.205 lb Speed 1 m/s = 3.60 * 106 \text{ J} 1 eV = 1.602 * 10-19 \text{ J} 1 u = 931.5 \text{ MeV} 1 hp = 746 \text{ W} Mass 1 kg = 1000 \text{ g} 1 kg weighs about 2.205 lb Speed 1 m/s = 3.60 * 106 \text{ J} 1 eV = 1.602 * 10-19 \text{ J} 1 u = 931.5 \text{ MeV} 1 hp = 746 \text{ W} Mass 1 kg = 1000 \text{ g} 1 kg weighs about 2.205 lb Speed 1 m/s = 3.60 * 106 \text{ J} 1 eV = 1.602 * 10-19 \text{ J} 1 u = 931.5 * 106 \text{ J} 2 eV = 1.602 * 10-19 \text{ J} 2 eV = 1.602 * 10-19 \text{ J} 2 eV = 1.602 * 10-19 \text{ J} 3 eV = 1.602 * 10-19 \text{ J} 4 eV = 1.602 * 10-19 \text{ J} 5 eV = 1.602 * 10-19 \text{ J} 5 eV = 1.602 * 10-19 \text{ J} 6 eV = 1.602 * 10-19 \text{ J} 6 eV = 1.602 * 10-19 \text{ J} 7 eV = 1.602 * 10-19 \text{ J} 8 eV = 1.602 * 10-19 \text{ J} 9 eV = 1.602 * 10-19 \text{ J} 8 eV = 1.602 * 10-19 \text{ J} 9 eV = 1.60
1/10 = 10-1 \ 2 = 1/100 = 1/10 = 10-2 \ 3 = 1/1000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 000 = 1/10 = 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10 \ 10-3 \ 4 = 1/10
distance Equatorial radius of the Sun Equatorial radius of the Sun Equatorial radius of the Earth Mass of the Sun Mass of the Sun Mass of the Sun Mass of the Sun Equatorial radius of the Sun Equatorial radius of the Sun Mass o
unit h hour atmosphere hp horsepower British thermal unit Hz Hertz coulomb in. Temperature inversion A condition in which the upper regions of the troposphere are warmer than the lower regions. When the parcel rises to an elevation of 2 km, its temperature is - 20 C. The anode in Figure 18.24 is the zinc cup, where zinc atoms lose electrons A
common dry-cell battery with a to form zinc ions: graphite rod immersed in a paste of ammonium chloride, manganese dioxide, and zinc chlorine and oxygen must lie in the same area of the periodic table. If black holes are invisible, what is the evidence for their
existence? Red light has a longer wavelength than violet light. (a) Show that the force acting on the egg when it hits the sheet is mv/t. The emerging light can be represented as a vector aligned with the polarization axes of the Polaroids. Oxygen atom Hydrogen atoms Water molecule, H2O The addition of heat causes these vibrations to increase until
at a certain temperature, the vibrations are rapid enough to disrupt the fixed arrangements. A positive sodium ion attracts the negative side of a water molecule, and a negative chloride ion attracts the positive side of a water molecule, and a negative chloride ion attracts the positive side of a water molecule.
domain of science? (a) The pH scale includes the concentrations of hydronium and hydroxide ions. Sandstone made of a mixture of minerals and angular rock fragments is called gray-wack-ee"). So we see that when an element ejects an alpha particle from its nucleus, the mass number of the resulting atom is decreased by 4,
and its atomic number is decreased by 2. In the Northern Hemisphere, tornadoes and hurricanes direction because of the . All else being equal, air composed of fast-moving molecules— warm air—exerts more air pressure on its surroundings than cooler air. Nitrogen Oxygen Products Reaction progress TUTORIAL: Equilibrium The energy
required to break bonds can also come from the absorption of electromagnetic radiation. It is important to continue artificial respiration. As mass is added to a pushed object, its acceleration (a) increases. What does saturation point have to do with dew point? LEARNING OBJECTIVE Summarize how electrons, when confined to an atom, behave like
self-reinforcing wavelike entities. What is the danger posed by people in the balcony of an auditorium stamping their feet in a steady rhythm? Although both pots absorb the same quantity of heat, the temperature increases three times as much in the pot with the smaller amount of water. Once the solution is shaken, so that are forced by pressure into
solumuch carbon dioxide escapes that the beverage froths over. But there's nothing water that has been distilled. Transverse wave A wave in which the wave nature of electrons also explains why they do not spiral closer and
closer to the positive nucleus that attracts them. 11.7 Polarization EXPLAIN THIS Why do Polaroid glasses reduce glare? In some cases, the exoplanet transits in front of the star, which causes the star to become slightly dimmer, again at detectable levels. A nyone who has ever lifted a submerged object out of water is familiar with buoyancy, the
apparent loss of weight of submerged objects. (d) neither an elastic nor an inelastic collision. 203 All batteries degrade. If all the minerals in a rock could melt simultaneously, the composition of the resulting magma would be the same as the composition of the original rock. Bases are also heavily used in industry. Notice that in both cases you are
 adding energy to the balloon. The masses of electrons are much less than the masses of protons (1:2000). As the carbon-based fuel combusts, it gains mass as it combines with the exhaust. How many forces are required for a single interaction? In the absence of
external forces, momentum is conserved in (a) an elastic collision. Paleozoic era The time of ancient life, from about 543 million years ago. Solution: (a) The frequency of the waves is given: one per 2 s, or f = 0.5 Hz (b) v = fl = fd. F I G U R E 8.19 An unusual source of voltage. The galvanized nail (bottom) is
protected from rusting by the sacrificial oxidation of zinc. Within the photosphere are relatively cool regions that appear as sunspots when viewed from Earth. The lithium-ion cells popular in notebook computers, cameras, and cell phones erode faster when highly charged and warm. (a) C, A, B. Polaris is always directly over (a) the North Pole. (Recall phones erode faster when highly charged and warm.
from Chapter 12 that an element is defined by its atomic number, which is the number of protons in the nucleus.) The changing of one chemical element to another is called transmutation. It is not. Note that the total distance covered increases as the square of the total time. Both dark energy, therefore, need to be included in
tabulations of the total composition of the universe. Paint spray 1 area units 1 layer thick Draw in 16 squares the size of A in here 4 area units () layer thick thick Force surrounding space: the electric field about an isolated electron, light from a match, radiation from a piece of uranium, and sound from
(d) how the particles were cemented and compacted. As you enter the ski lodge, your eyeglasses fog up. F I G U R E 8.1 A plastic straw rubbed with wool is suspended by a thread. The logarithm of 0.0001, which equals 10-4, for example, is - 4 (the power to which 10 is raised to equal this number). Momentum, like the quantities velocity and force
has both direction and magnitude. Thermonuclear fusion reactions produce an outward pressure that counteracts the inward pressure that would lead to collapse due to gravity. microtechnology techniques to smaller and smaller scales. F I G U R E 6 .1 8 A pre-electronic thermostat. There are about 7 billion people on Earth. Failure to make this
distinction resulted in disagreements and arguments between the best British and French physicists for almost two centuries. What do these two structures have in common? Ne .. Both a lithium atom are in the second period of the periodic table, which means that both contain two shells of electrons. A polymorph is two or more
minerals that contain the same elements in the same proportions but with different arrangements of atoms. n automobile parked in the street in the bright Sun on a hot day with closed windows can get very hot inside—appreciably hotter than the outside air. Atoms are so incredibly small that we can never see them in the usual sense. A star inflates
dimethyl ether, CH3OCH3, which has the same number and kinds of atoms, does not. What is the relationship between the hydroxide ion and a water molecule? Gray to black shale indicates the presence of organic matter, which can be preserved only in environments with little or no oxygen, such as swampy areas. In an economy that has a steady
inflation rate of 7 percent per year, in how many years does a dollar lose half its value? Do yourself a favor and hold a Ping-Pong ball up to the sunlight to see how the position of the sphere determines its phase. Hydrocarbons release a lot of energy when ignited. Both pounds and newtons are units of weight, which in turn, are units of force. atoms,
356 Ellipse, 107 Elliptical galaxies, 756 Elliptical gristian, 757 Elliptical orbits, 107-108 Endothermic reactions, 441-446 conservation of, 76 dark, 783-785 electric potential, 189-190 kinetic, 73, 75 potential, 72-73 radiant. When the weightlifter raises the
barbell from the floor, she does work on it. (b) 1 billion years old. This decreases their size and rounds off their sharp edges. Interestingly, very deep bodies of water are not ice-covered even in the coldest of winters. Several of his texts were reintroduced to Europe during
the 11th and 12th centuries and were translated into Latin. The gravitational pull at the Moon's surface is less than the speeds that molecules of gas would have at regular Moon temperatures, so any gases on the Moon escape. Skipping flat rocks off the surface of a pond provides an appropriate
analogy. If the particle is released, * This work is positive if it increases the electric potential energy of the charged particle and negative if it decreases it. Comment on the warning sign shown in the sketch. 2 Acid enters lake from rain. Spectral patterns of hydrogen and some other known elements were observed, in addition to one pattern that could
not be identified. The longer waves are canceled by interference. You feel the same pressure a meter deep in a small pool as you do a meter deep in the middle of the ocean. All periodic waves, however complicated, can be broken down into constituent sine waves of different amplitudes and frequencies. This is similar to running in a rain that comes
down at an angle. Neither, for both forces have the same magnitude. (a) d = vxt = vt. Which person reaches terminal speed first? What doesn't change during a physical change? Striking the nail shakes up the domains, allowing them to realign themselves with Earth's magnetic field. A hydrogen bomb produces fission energy as well as fusion energy
Why isn't water classified as an element? One kilowatt (kW) equals 1000 W. Water and less-dense materials spill out when the mixture is swirled. Part of the Slinky is compressed, and a wave of compression travels along it. Under the pressure of overlying sediments, oil droplets are squeezed out into overlying porous sedimentary rocks that become
reservoirs. FIGURE 9.28 Mechanical input Electrical output INTERACTIVE FIGURE A simple generator. The cross-sectional shape of a stream channel determines the amount of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water that is in contact with the channel of water than the channel of water that is in contact with the channel of water than the channel of wat
this distance as the radius of a circle on a map, you know the disturbance occurred somewhere on that circle. You may have noticed that vanilla seed pods and vanilla extract are fairly expensive. If we equate the formula for acceleration, a = \mathbb{C}/\mathbb{C}t, we get F/m = \mathbb{C}/\mathbb{C}t, we get F/m = \mathbb{C}/\mathbb{C}t. Figure 19.29 shows that using styrenestical extract are fairly expensive. If we equate the formula for acceleration actually is, a = \mathbb{C}/\mathbb{C}t, we get F/m = \mathbb{C}/\mathbb{C}t.
as the monomer yields polystyrene. A piece of solid iron sinks in a container of molten iron. From Mars it appears about half the size of our Moon. Instead, it held tight, expanding "slowly" for as long as it could before bursting like a bubble, which then calmed down almost immediately, but not before a dramatic inflation of space. 106 Red giant stage
105 4 3 Gravitational collapse 103 ain M 2 gu se 102 en Helium burning ce Energy output (Sun = 1) 104 101 White dwarf (0.65 solar mass) 1 1 Hydrogen burning 1 solar mass 5 10-1 F I G U R E 2 7.1 2 0 20 0 00 40 00 60 00 10-2 10 0 The stages of the Sun's life cycle are plotted on this H-R diagram. The impulse
required to bring an object to a stop and then to "throw it back again" is greater than the impulse required merely to bring the object to a stop. Most transform faults are found in the ocean basin and connect offsets in the mid-ocean ridges, electron "imported" from some other atom. When all three types of cones are stimulated equally, we see white.
The hydrogen, therefore, is oxidized. How much force/mass (usually the cause) determines the rate change in velocity/time (usually the effect). Hubble's great accomplishment was collecting both the distance and redshift data for many galaxies and then correlating these data on a graph. You'll see the mathematical structure in frequent equations,
but you'll find them guides to thinking rather than recipes for computation. A farmer urges his horse to pull a wagon. The Hawaiian Islands are made up of predominantly volcanic igneous rock. According to the scale's reading, you would be weightless. Following through extends the time of contact. You can visualize a simplified model of your
metabolism by reviewing Figure 18.36 and substituting a food molecule for the methane. The crust rides atop tectonic plates that move in response to heat flow and convection in Earth's interior. So the maximum range for heavy projectiles thrown by humans is attained for angles of less than 45°—and not because of air resistance. Or is the volume of
water flowing from the faucets the same? Both the bullet and the whip are not in themselves sound sources, but when they travel at supersonic speeds, they produce their own sound as they generate shock waves. A transformer for a laptop computer converts a 120-V input to a 24-V output. 2 The Formation of Ions 15. ...I . Solar energy striking the
land is concentrated at the surface, but energy striking the water extends beneath the surface and so is "diluted." Water is useful in the cooling systems of automobiles and other engines because it absorbs a great quantity of heat for small increases in temperature. Red te Whi Blue F I G U R E 11. If levels are abnormally high, corrective measures
such as sealing the basement floor and walls and maintaining adequate ventilation are recommended. A carboxylic acid is a carbonyl-containing organic molecule in which the carbonyl carbon is bonded to a hydroxyl group. Friends in your discussion group say that when you touch a piece of ice, the cold flows from the ice to your hand, and that's why
your hand is cooled. Knowledge doesn't subtract—it adds. Electrode Any material that conducts electrons into or out of a medium in which electrochemical reactions are occurring. For example, if one scale reads twothirds your weight, the more concentrated
the solution is. (c) Replacement occurs when mineral matter replaces the remains of an organism. 688 PARTHSCIENCETo see that expanding air FYI cools, blow on your hand with your mouth wide open. Astronomers have measured the luminosity of many stars and found that stars vary greatly in this respect. If you were on
the Moon and you looked up and saw a full Earth, would it be nighttime or daytime on the Moon? An element found in another galaxy exists as two isotopes. A great advantage of using chlorine gas is that it C H A P T E R 16 Skimmer Grit chamber Chlorine Sludge Raw sewage Grit To solid-waste disposal site To secondary treatment or outfall A
schematic for primary-level wastewater treatment. There would be spectacular meteor showers high in the atmosphere. But the ions that are normally found in water make it a fair conductor. Xe .. But inflation will keep on going for other patches of this primordial material and will continue to do so eternally. Melting The process of changing phase
from solid to liquid, as from ice to water. Because subscripts of 1 are implied when not written, we have not MgCl2. And when you pull on a cart and it accelerates, the cart pulls back on you, as evidenced perhaps by the tightening of the rope wrapped around your hand. Earthquakes occur along the subduction zones as the subducted
plate grinds against the overriding plate and the subducted plate is compressed and fractured. Your garage gets messier by the day. Likewise, the work done in pushing a charged particle closer to the charged particle 
would expect, the hottest main-sequence stars are the brightest and bluest stars are the most dim and red stars. These steps are combined in step (a) of Sample Problem 2. 150 PA R T O N E P H Y S I CS The only weight-loss plan FYI endorsed by the first law of thermodynamics: Burn more calories than you
consume and you will lose weight—guaranteed. FIGURE 12.30 The first three periods of the periodic table according to the shell model. This is the principle behind the Teflon nonstick surface. (Hint: The existence of cosmic rays was first indicated by this observation.) 100. after a jump? Looking more like flying bullets than flying squirrels, high-
performance wingsuits allow these "bird people" to glide with remarkable precision. It's made in one place and used in another. Some forms of radiation are more harmful than others. A neutron star, enormously dense, is what remains after a supernova. The most concentrated source of usable energy is that stored in nuclear fuels—uranium and
plutonium. 17.5 Energy and Chemical Reactions 21. A friend says that adding bulbs in series to a circuit provides more obstacles to the flow of charge, so there is less current with more bulbs, but adding bulbs in parallel provides more paths so more current can flow. Figure 17.8 shows that with higher concentrations, more molecules are in a given
volume, which makes collisions between molecules more probable. throughout. Greenhouse effect Warming caused by short-wavelength radiant energy from the Sun that easily enters the atmosphere and is absorbed by Earth. At low speeds, the cannonball curves downward and gains speed because there is a component of the force of gravity along
its direction of motion. What is your explanation? The sum of the distances from any point on the path to two points called foci is a constant. The fact that a color and its complement combine to produce white light is pleasantly used in lighting stage performances. It is humans who use the technology, and humans who are responsible for how it is
used. When heat is subtracted from an air mass, the temperature or the pressure end to the low-pressure end to the low-pressure end to the low-pressure end to the low-pressure end. Lakes and streams are filled with not water but
liquid methane. Comets are icy bodies that orbit the Sun. Twice as much volume? So we see that changes in an object's motion depend both on force and on how long the force acts. Soluble Capable of dissolving to an appreciable extent in a given solvent. Resistance Line Switch Valve FIGURE 8.21 Pump (a) Voltage source (b) Analogy between (a) a
simple hydraulic circuit and (b) an electric circuit. This lowers the pH of the inner wall of the stomach, which can damage the tissues and even cause bleeding. If your arms were as light, they'd stand out too. For example, they do not normally penetrate through light materials such as paper or clothing. Cole, Sympathetic Vibrations (New York:
Morrow, 1984). Three years later, Croatian seismologist Andrija Mohorovic i'c (pronounced "moho-rovu-chick") analyzed seismic readings from a recent earthquake. This "fluid" of electrons holds the positively charged metal ions together in the type of chemical bond known as a metallic bond. 2 kg pillow 15 kg iron A A B C 59. The voltage induced in
each is the same, providing the loops are the same size and the magnet moves with the same speed of a falling object (without air resistance) nor the speed of a falling object (without air resistance) nor the speed of a satellite in orbit depends on its mass. Note that the first three periods here parallel Figure 12.30. What do you say to your friend? (c) The change in velocity is 10 m/sectors.
during this 1-s interval (or any other 1-s interval). C H A P T E R 13 REVIEW 345 T H I N K A N D R A N K (A N A LY S I S) 33. Like wetlands today, Silurian wetlands were productive habitats with considerable biodiversity. To compensate for the weakening of the strong nuclear force across the diameter of the nucleus, large nuclei have more
neutrons than protons. See also Sound waves speed of, 240 standing, 250-251 transverse, 241-242 Wave refraction, 654-655 Wavelength, 239 Weather, 682-706 adiabatic processes and, 686-689 air density and, 686-688 air masses and, 686-689 atmospheric moisture and, 683-686
atmospheric stability and, 688-689 clouds and, 688-689 clouds and, 687-698 precipitation formation and, 697-698 weather maps, 702 Weathering, 539-540 Weight, 18, 93
95-96 mass and, 17-18 Weightlessness, 95-96 Wells, artesian, 594 White dwarfs, 743 Wind energy, 80 Work energy and, 70-75 units of, 71 Work-energy theorem, 74-75 This page intentionally left blank The moment you know. See also Big Bang galaxies in, 754-767 Kuiper belt in, 729-730 meteors in, 729, 732 Moon in, 722-728 Oort clouds in, 731
planets in, 709, 714-721 scale of, 710 stars in, 738-763 Sun in, 712-714 Solids. Dark matter is (a) ordinary matter that is no longer emitting light. Aldehyde An organic molecule containing a carbonyl group, the carbon of which is bonded either to one carbon atom and one hydrogen atoms. What did Newton discover about
 gravity? The conservation of angular momentum is far-reaching. How does the magnitude of electrical force between a pair of charged particles change when the particles are moved twice as far apart? Vibrations in the electrical force between a pair of charged particles change when the particles are moved twice as far apart? Vibrations in the electrical signal cause the cone to vibrate. Newton's second law tells us that a = Fnet/m. 34 PA R T O N E P H Y S I CS (c) What is
the change in its velocity, ©v, during this 1-s interval? What happens to the pH of soda water as it loses its carbonation? If the charges are deflected in opposite directions, what does this tell you about the particles? The answer is, they do fall! They fall at the same speed at which the air is rising, and therefore they remain fixed in elevation.
CHECKPOINT Which of these statements is a scientific hypothesis? We enjoy physical science, and you will too—because you'll understand it. Calcium fluoride ion, F-. When you jump, you tighten the disks similar to tightening a
Suchocki/Paul G. A hammer? The larger mica flakes give the rock a highly reflective surface that is quite striking. Both frequencies are the same. The dipole-induced dipole attraction is stronger and involves a permanent dipole attraction is stronger and involves a permanent dipole and a temporary one. At temperatures below the boiling point, the vapor pressure is not great enough. The perception of a
longer time is one of many illusions we have about nature. Or the 32 4 8 15 grains placed on the sixth square is one more than the total of 5 16 31 31 grains that were already on the board. midpoint, of the vibration. Thus we see that hot blue stars are more luminous than cooler red stars of the same size. What relative direction between a magnetic
field and a current-carrying wire results in the greatest force on the wire? But most minerals either occur in a variety of colors or can be colorless. Hewitt 348: John Suchocki/Paul G. A divergent boundary, or midocean spreading ridge, separates the two plates. The mineral muscovite displays very distinct cleavage, yet the mineral quartz fractures.
(Hold the cups up to your cheeks to tell.) Is this an exothermic or endothermic process? What happens to the mass? H Cl Hydrogen chloride (acid) H N H H OH Pseudoephedrine (base) 

■ H H CH3 N CH3 C C Hydrogen chloride (acid) H N H H OH Pseudoephedrine (base)
readily absorbed into the body. Inverse-square law, as do the effects of electric, light, sound, and radiation phenomena. Speed is a localized source spreads uniformly throughout the surrounding space and weakens with the inverse-square law, as do the effects of electric, light, sound, and radiation phenomena. Speed is a
description of how fast; velocity is a description of how fast and in what direction. Sound waves therefore tend to bend away from the ground, resulting in sound that does not seem to transmit well (Figure 10.13). CHAPTER 8 S TAT I C A N D CU R R E N T E L E C T R I CI T Y 193 F I G U R E 8 .11 Bits of thread suspended in an oil bath line up end-
to-end along the direction of the field. Rather than moving in neat orbits like planets around the Sun, electrons are wavelike entities that swarm in various volumes of space called shells. This enables us to calculate the star's spin rate. This is one of the main responsibilities of government, which, ideally, is there to represent the collective will. How is
the darkness of sunspots similar to the black parts of an image on a TV screen? Is the pressure higher or lower in regions of crowded streamlines? Discuss the branches caress back on the wind to produce whistling sounds. The magnitude of bond polarity is sometimes
indicated by the size of the crossed arrow or the d - and d + symbols used to depict a dipole, as shown in Figure 15.23. 2020 Dec 14 203 Ju l. (b) How about the wavelength reaching your ear? Now we will also see that igneous rock breaks down to form sedimentary rock, and that a third rock type—metamorphic rock—forms from rocks that already
exist. For example, we would need an efficient method for generating hydrogen. Why are atmospheric CO2 levels routinely up to 15 ppm higher in the spring than in the fall? Providing electricity (for home heating and cooking) to rural developing areas is effective in reducing the burning of biofuels. What is the chemical structure for this compound?
Reducing agents are oxidized in oxidation-reduction reactions. Show that the average speed of a rabbit that runs a distance of 30 m in a time of 2 s is 15 m/s. The number of molecules. Alternatively, hold the pennies in opposite hands to see
if you can feel the difference in their masses. Sandstone that contains considerable amounts of the mineral feldspar is called arkose. Likewise, nine times the work is required to triple the speed (32 = 9). Surrounding the nucleus are the tiny electrons, as shown in Figure 12.2. ATO M S A N D T H E P E R I O D I C TA B L E 295 LEARNING OBJECTIVE
or subtracted? All these things vibrate. 40. Atoms usually have as many electrons as protons, so the atom has zero net charge. To name just one more example, neon atoms emit a brilliant redorange light, which makes them useful as the light source in neon signs. When you push the rug, it can (1) fold upward or (2) fold downward. Television sets,
fallout from nuclear testing, and the coal and nuclear power industries are also contributors. Type of Bond Number of Moles HiH O"O Bond Energy absorbed: 2 1 +872 kJ +498 kJ + 1370 kJ In the products there are four hydrogen-oxygen bonds. The examples in the three preceding exercises can
over great distances and allows smaller crystals to merge, so relatively large crystals form. Rocks are divided into the following three categories based on how they were formed: Igneous rocks are formed by the cooling and crystallization of hot, molten rock. Earth rotates about its axis and therefore about the North Star, so over a 24-hour period the
Big Dipper (and other surrounding star groups) makes a complete revolution. Just as we think of minerals as chemical mixtures or compounds, rocks can be thought of as physical mixtures or compounds, rocks can be thought of as physical mixtures. To understand why, ask yourself which is more willing to lend its lone pair to the positive charge on another molecule. But a fast car can have more momentum
no sound at all. Why Clouds Are White Clouds are made up of clusters of water droplets in a variety of sizes. The highest frequency is in Texas through Oklahoma, Kansas, and Missouri, a zone known as Tornado Alley. Getting ready to leave your room for the beach, you put on your sunglasses. This energy is mainly in the form of kinetic energy of the
fission fragments that fly apart from one another, with some energy given to ejected Otto Hahn, rather than Lise neutrons and the rest to gamma radiation. When shaken more vigorously (at a high frequency), a wave of shorter wavelength is produced. SBR is an addition polymer made from the monomers 1,3-butadiene and styrene mixed together in a
3:1 ratio. Gravitational forces act on a star. Rank the voltage readings from highest to lowest. Black-hole singularity The object of zero radius into which the matter of a black hole is compressed. Hard plastic dishes (Melmac) and countertops (Formica) are made of this material. Artesian systems form where aguifers become sandwiched between low-
permeability rocks, forming a confined aquifer. So you switch to your infrared telescope and see that as the probe gets closer to the black hole its clock slows to a creep. When the ideas of science are expressed in mathematical terms, they are unambiguous. But when steam molecules encounter water in the pan, they stick to the water surface
Although the impulses may be the same for the two cases, the times of impact are not. Is the current in a lightbulb connected to a 220-V source? The number of turns on each secondary varies as indicated. (b) 10 m/s per second. How profound that all the moons and
planets and stars and galaxies have such a beautifully simple rule to govern them, namely: m1 m2 d2 The formulation of this simple rule is one of the world might also be described by equally simple and universal laws. How much smaller does your
hand look when it is twice as far from your eye? If the hydrogen and oxygen have the same temperature, then by definition they have the same average kinetic energies per molecule. Metal lids on glass fruit jars can often be loosened by heating them under hot water. Is it possible to have a sample of oxygen that has a mass of 14 amu? Dark energy An
unknown form of energy that appears to be causing an acceleration of the expansion of space; thought to be associated with the energy exuded by a perfect vacuum. The lowest frequency, determines the pitch of the note. Emily Easygo can paddle a canoe in still water at 8 km/h. FIGURE 15.36 The electrical part of the expansion of space; thought to be associated with the energy exuded by a perfect vacuum.
attraction between water and oxygen molecules is relatively weak, which explains why not much oxygen is able to dissolve in water. Water is a polar molecule because in its structure the dipoles do not cancel. c, 9. Note how the magnitudes of the two upward vectors equal the magnitudes of the three downward vectors. With your friends, whirl
bucket of water in a vertical circle fast enough so the water doesn't spill out. TA B L E 2 8. The giant and supergiant stars shown here as circles are not drawn to scale. Nearly 300 years later, in 1969, when TV showed astronauts first landing on the Moon, millions of people in their living rooms noticed the time delay between conversations (at the
   beed of light) between the astronauts and the earthlings at Mission Control. So whether you consider the door to be an insulator or a conductor, the balloon sticks by induction. When we say that we boil water, it is common to mean we are heating it. The minerals formed are determined by the elements present and the conditions that lead to their
formation. So the mass of water vapor in 1 m3 of air is 3.6 g. They outclass almost all other known materials in their ability to absorb hydrogen molecules. Sometimes a radiated cell survives with a damaged DNA molecule. Closely packed atoms and ions have a smaller distance between one another, and thus they form stronger bonds because they
attract one another with more force. The sodium and chloride ions in a salt crystal, for example, hold together in a cubic orientation, and, as a result, the macroscopic object we know as a salt crystal is also cubic. Olivine and pyroxene are both ferromagnesian silicate minerals that crystallize from cooling magma. The water content of the rock also
changes with distance. Earth would be so bright, however, that you could clearly see your shadow. That is, the force that propels a rocket exerts on the exhaust gases 2 electrons are forced to vibrate in the antenna of a radio station's transmitting. The source of
any wave is something tower. (b) The landing speed is 60 km/h + 40 km/h = 100 km/h (now you see why planes land in a headwind and not a tail wind). Out in nature, the freezing process mechanically breaks rock apart. In fact, air's density is proportional to its pressure. (b) tiny domains of aligned atoms. 35. By definition, force * distance equals the
concept we call work. 1 The Universal Law of Gravity 4. According to the formula liquid pressure increases with an increase in density. We say "cooled enough" because the universe was still quite hot, but not as hot as before. Hence, saturated fats, such as lard, are solid at a concept we call work.
room temperature. So whether a substance is a solid, a liquid, a gas, or a plasma depends on the motion of its particles. Vast carbonate and evaporite deposits on the continents are evidence that expansive, shallow (b) seas have periodically covered the land surfaces in the past. Divide the number of water molecules by the total number of molecules
and multiply by 100 to get the percentage: 999,999 million trillion/1,000,000 million trillion * 100 = 99.9999% 33. This is done by heating the ore with electron-releasing materials, such as carbon, in hot furnaces that reach about 1500°C. CH3 O O C H H3C Isoprene (2-methyl-1,3-butadiene) Camphor CH3 Citral 67. Electrochemistry is the study of
electrical energy and chemical changes. It spins once every 16 days and has a methane atmosphere with attention at the attention at 
windward (upslope) side of the mountain. Would you use a physical model or a conceptual model to describe the following: a gold coin, dollar bill, car engine, air pollution, virus, spread of sexually transmitted disease? Like microtechnology, nanotechnology is interdisciplinary, requiring the cooperative efforts of chemists, engineers, physicists,
molecular biologists, and many others. Rank the net force on the block from greatest to least in the four situations A, B, C, and D. 8.6 Electric Current 17. This good advice is often misunderstood by those who then think that sunlight is more damaging at this special time. (a). In this way the entire line current must pass through the fuse. PETE has a
Tg of around 69°C, which is why a PETE 2-L bottle deforms so easily when placed in boiling water. Rank these quantities from greatest to least at each point A-E: (a) speed, (b) KE, and (c) PE. Sr. How does this relate to opening a bottle of perfume in the corner of a room? This slippery effect is why graphite is used as a dry lubricant. A pair of sound
waves of different wavelengths reach the listener's ear as shown. Is the universe in space or is space in the universe? This technology allowed for the mass production of metal tools and weapons and made possible the many achievements of ancient Chinese, Egyptian, and Greek civilizations. For clouds to form, air must be lifted. The voltage is
therefore the same across each device. Stay tuned for current developments. We will explore the first two mechanisms in more detail in Chapter 21, where we can link them to the plate tectonic model. It is equal to the mass multiplied by the square of the speed, multiplied by the constant 12: Kinetic energy = 1 2 mass * speed2 KE = 1 2 mv2
Gravitational potential energy always involves two interacting objects—one relative to the other. How thick would the patch be if the experiment were done in a sphere with twice the radius? (b) less mass per nucleon. Water absorbs more heat than iron for the same change in temperature. Sam pushes crates starting from rest across the floor of his
classroom for 3 s with a net force as shown above. As we learned in Chapter 7, air cools when it expands. People with hip implants appreciate the transition metals titanium, Ti; molybdenum, Mo; and manganese, Mn, because these noncorrosive metals are used in implant devices. Because some of the added heat goes into doing work, less of the
added heat goes into increasing the thermal energy of the enclosed air. Is the formation of ozone from oxygen an endothermic or exothermic reaction? Hewitt (middle) Hu Meidor/Paul G. For example, Pluto orbits at an angle to the plane of Earth's orbit—the ecliptic. Physical model A representation of an object on some convenient scale. This can be
remedied by placing a coefficient of 3 by the hydrogen, H2, and a coefficient of 2 by the ammonia, NH3. (a) 5 N (b) 10 N (c) 15 N (d) none of these 5. Unlike the ones used by potters for spinning clay, modern flywheels are made of lightweight composite materials that are strong and can be spun at high speeds without coming apart. When a
rechargeable battery is being recharged, however, what was once the negative anode now becomes the negative cathode, which is where electrons are needed for reduction. Joseph Henry's first electromagnets. We agreed that it should have, because even more
of the load was then supported by Burl's rope. Each molecule in the air vibrates to and fro about some equilibrium position as Rarefactions the waves move by. What most strongly influences a mineral's hardness? (b) continental, orogeny, and occluded lifting. When a car is moved into a painting chamber, a mist of paint is sprayed around its body.
This might seem like a great number of electrons, but it only represents the amount of charge that flows through a common 100-W lightbulb in a little more than a second. Notice that you cannot see the steam that issues from the spout. View crystals of table salt with a magnifying glass or, better yet, a microscope if one is available. When our Sun
turns into a red giant billions of years from now, its diameter will encompass the orbit of Venus. Would the speed of a satellite in close circular orbit about Jupiter be greater than, equal to, or less than 8 km/s? If one block moves relative to the other b Lim b Lim become folded. Because of the double bond, two of the carbons of the unsaturated
hydrocarbon 2-butene are bonded to only three other atoms, which makes the molecule an unsaturated hydrocarbon. What is its weight in newtons? Demonstrate charging by friction and discharging from pointed objects with a friend who stands at the far end of a carpeted room. The crust's vertical position, as well as the ship's, is determined by the
balance of the buoyant and gravitational forces acting on it. We say they are out of phase with one another. We will not study curved mirrors in this text, except to say that a curved mirror behaves as a succession of flat mirrors, each at a slightly different angular orientation from the one next to it. T H I N K A N D R A N K (A N A LY S I S) 58.
LEARNING OBJECTIVE Describe the nature of convection in fluids. 480 PA R T T W O CH E M I S T RY Researchers have discovered that mice and other animals breathing certain concentrations of hydrogen sulfide gas, H2S, enter a state of suspended animation where the body temperature fluctuates only a few degrees above the surrounding
temperature. 16.7 EXPLAIN THIS T FIGURE 16.36 In Honolulu, about 280 million liters of wastewater pass through the largest of several wastewater facilities each day. But it so happens that a body weighs scarcely three times as much on the surface of Jupiter as it weighs on the surface of Earth. In units of "tosses," what is the average half-life of 25
coins? The magnetic fields so induced are then detected by the circuit.) 77. What is the net force on a box pushed to the right with 50 N of force while being pushed to the left with 20 N of force? The circle at the center describes the overall appearance of the sky. The Tg of polystyrene is around 100°C. Periods and Groups Two other important ways in
which the elements are organized in the periodic table are by horizontal rows and vertical columns. In Chapter 4 we'll extend our definition of weight to be the force of a body pressing against a weighing scale). As you sleep in a reclined position, pressure is taken off of the discs in your spinal column, which allows them
to expand so that you are significantly taller in the morning. Wai Tsan Lee shows iron nails becoming induced magnets. According to Einstein, however, we would say that spacetime became more flat, which allowed us to move along our merry way. The graveyard of mechanical energy is thermal energy. 736 PARTFOUR ASTRONOMY 77. We
thank Phil Wolf, who authored many of the Think and Solve problems, and David Housden, Evan Jones and John Sperry for contributing to their solutions. Note the development of the ring systems, which continue to expand outward. The rock cools and the water warms. A ball is hovering in front of you. Newton's "speech" was very brief; he simply
requested that a window be closed because of a draft. That's true whatever their masses because each will have the same amount of momentum but in the opposite direction from the other. The term bonding pair refers to any pair that
results from formation of a covalent bond. The more violent the jumping, the more difficult it is to keep holding hands. We cannot stop or return, only go. In Chapter 1 acceleration is defined as a = ©v ©t. 2 6 Thermal energy is released by steam when it condenses inside the "radiator." a b c d F I G U R E 7. D C C B 61. The friction of your finger
excites standing waves in the glass, much like the wave made on the strings of a violin bow. Surface features on Mars, such as channels, indicate that liquid water was once abundant on this planet. c, 2. Now that the shallow seas are gone, the carbonate rocks are exposed. Which should be larger: the potassium ion, K +, or
the argon atom, Ar? As m decreases (much is the mass of the fuel), acceleration a increases while force F remains constant. Knowing that a 1-kg object weighs 10 N, confirm that the acceleration of a 1-kg stone in free fall is 10 m/s2. If true, that means there are about 1022 stars in our observable universe, which is about the same number of water
molecules in a drop of water. In general, we can state that the product of pressure and volume for a given mass of gas is a constant as long as the temperature does not change. The Andromeda galaxy is our closest spiral neighbor, being only some 2.5 million light-years away. The reflected colors of most objects are not pure single-frequency colors
but are a mixture of frequencies. (d) polarized. The rates of these transformations would be about 1:1. TUTORIAL: Formation of the Solar System VIDEO: History of the Solar System VIDEO: Orbits in the Solar System The ancients could tell the
difference between planets and stars because of the difference in their movements in the sky. How can you tell? G-9 Rock cycle A sequence of events involving the formation, and reformation, and reformation of rocks as a result of the generation and movement of magma; the weathering, erosion, transportation, and deposition of sediment; and
the metamorphism of preexisting rocks. Rank the current readings in the ammeter from highest to lowest. 120 Solubility increases with increasing temperature 100 because hot water molecules have greater kinetic en80 ergy and therefore can collide with the solid solute 60 more vigorously. F I G U R E 4 .1 2 (left) Drop a ball, and it accelerates
downward and covers a greater vertical distance each second. Like all practical systems, more energy is put in than is supplied for useful purposes. The pressure a greater vertical distance each second. Like all practical systems, more energy is put in than is supplied for useful purposes. The pressure a greater vertical distance each second. Like all practical systems, more energy is put in than is supplied for useful purposes. The pressure due to a liquid is precisely equal to the product of weight density and depth:** Liquid pressure = weight density * depth * Pressure may be measured in any unit of force divided by any unit
of area. How is the number of unpaired valence electrons in an atom related to the number of bonds that the atom can form? Why is flushing a toilet with bottled water? 364 PART TWO CHEMISTRY 46. About a charged point, the field decreases with distance according to
the inverse-square law, like a gravitational field. A C T I V I T I E S (HANDS-ONAPPLICATION) 31. Upon inflation, ultrasmall quantum variations in position and momenta would have been magnified. So what would it be like if there were a sizable population of 200-year-olds in society? LEARNING OBJECTIVE Describe the physical
properties used to identify minerals. 6 Carbonyl Compounds 19. Look for round "Sun balls" on your next sunny day outside. Of course, you wouldn't be able to see the wall either. The flavor of vanilla, for example, is perceived when the compound vanillin is absorbed by the sensory organs in the nose. If this doesn't seem fast, convert it to kilometers
per hour and you get an impressive 29,000 km/h (or 18,000 mi/h)! At this speed, atmospheric friction would burn the baseball—or even a piece of iron—to a crisp. The amount of matter lost or gained in a chemical reaction, however, is so small that, for all practical purposes, we can ignore this detail. Which has more volume? The nucleus is composed
of nucleons, which, as discussed in Chapter 12, is the collective name for protons and neutrons. The mass of the paper is 0.003 kg. what sounds or pictures to make. (Hint: Take into account the wideness of the solar radiation curve.) C H A P T E R 11 79. Active Galaxies differ greatly in the activity going on inside them. The charge of neon's
nucleus is 10 + . When two air masses make contact, differences in temperature, moisture, and pressure can cause one air mass to ride over the other. 12 kg sand 10 N A 5N 7N B 3N 12 N C 4N 3N D 3N 60. In some shown earlier for ionic compounds representations, the nonbonding electron pairs are ignored. 9.2 Magnetic Fields 4. The remarkable
thing to note from Figure 4.19 is that the same range is obtained from two different launching angles when the same range as if it were thrown at the same speed at an angle of 30°. As the temperature, evaporation of temperature and humidity (not rate, and
saturation vapor pressure all increased, the air could accommodate relative humidity). Earthquake-prone regions experience large earthquakes about every 50 to 100 years. Test to see which of your ears has better hearing by covering one ear and finding how far away your open ear can hear the ticking of a clock; repeat for the other ear. Chemical
batteries or generators are "electrical pumps" that can maintain a steady flow of charge. Neither fission nor fusion will result in a decrease of mass for iron nucleons. A complete to-and-fro oscillation is one vibration. (d) larger minerals are more stable than smaller ones. They come in all shapes and sizes, but the largest asteroid, Ceres, is just under a
thousand kilometers in diameter. A decrease in frequency, or toward the red end of the color spectrum. Notice that some of the nuclei in the series can decay in both ways. In the following sections, we shall briefly discuss circuits using these two types of connections. The ear is hard-
pressed to distinguish between the high pressure caused by an explosion and that produced by many overlapping waves. The combustion of these and other carbon-based chemicals forms carbon dioxide and water. P L U G A N D C H U G (F O R M U L A FA M I L I A R I Z AT I O N) Frequency g 1 period 39. What is the net force acting on a 1-kg ballower.
in free fall? What changes would you make to convert this pump into an air compressor? According to the model, photons are emitted by atoms as electrons move from higher-energy outer orbits. Thermodynamics The study of thermal energy and its relationship to heat and work. Consider a batted baseball following a
parabolic path on a day when the Sun is directly overhead. CHAP TER 27 TA B L E 2 7. Jupiter has more than 60 moons in addition to a faint ring. By swift execution, she makes the force of impact huge. FIGURE 16.2 A B C Was this your answer? We know that a cubic meter of air at ordinary
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atmospheric pressure and room temperature has a mass of about 1.2 kg, so its weight is about 1.2 N. Earth is approximately 4.5 billion years old. K S K+ + 1e- 19. Why doesn't this distance accumulate and set a total of 90 mL of BBs of mixed
sizes. At constant velocity there is no acceleration. Motion is relative. But along the transform fault, lithosphere is moving in opposite directions. Kinetic energy, such as chemical energy, sound, and light. 0.0111 * 13.0034 0.144 atomic
mass = 11.867 + 0.144 = 12.011 step 2 Solution: FIGURE 12.8 Contributing Mass of 13C 9 F 18.998 17 Atomic mass units 10 Ne 20.180 18 Cl Ar 35.453 35 39.948 36 Br Kr CHECKPOINT Distinguish between mass number and atomic mass in atomic mass units 10 Ne 20.180 18 Cl Ar 35.453 35 39.948 36 Br Kr CHECKPOINT Distinguish between mass number and atomic mass in atomic mass
the amount of energy in light, for example, transforms completely to thermal energy when the light is absorbed. An easier cell to construct is the citrus cell. P = I * V = (0.5 \text{ A})(120 \text{ V}) = 60 \text{ W}. In either case, the law of reflection holds for each ray. Rank these bonds in order of increasing polarity: (a) C i H, (b) C i H, (c) C i H, (d) C i H, (e) C i H, (f) C i H, (f) C i H, (g) C i H, (g) C i H, (h) C i H, (g) C i H, (h) C i H,
its container. At age 80, he still had all his teeth, his eyesight and hearing were sharp, and his mind was alert. Answer: Any good insulator is a poor conductor. The UV light needed to activate transition eyeglasses doesn't get through the window glass. Schist
is one of the most easily recognizable metamorphic rocks because it is scaly looking with large micas that reflect light like tinted windows. Richter magnitude is based on the maximum seismic-wave amplitude of an earthquake, as recorded by a seismograph. Hewitt Dennis Wong/Paul G. Although air resistance is not present in a vacuum, gravity is.
CHECKPOINT Isn't it true that knowing why rainbows are round and why they're colored adds to their beauty? Injury by electric shock occurs in three forms: (1) burning of tissues by heating, (2) contraction of muscles, and (3) disruption of cardiac rhythm. Oceanic-oceanic convergence (Figure 21.23a) 2. When rock is heated, it rises and expands—
making it less dense. Figure 27.9 shows the radiation curves, which are graphs of the intensity of emitted radiation versus wavelength for two stars of the same size with different temperatures. We have seen that light is absorbed when it resonates with electrons of atoms and molecules in a material. What is the common name for dioxygen oxide?
101. Whether one object is warmer than another has most to do with (a) molecular kinetic energy. What is the net force that acts on a 10-N freely falling object? Insert a pencil into a Styrofoam ball. Both P- and S-waves are strongly refracted at the core-mantle boundary, causing a wave shadow. 2 8 The motion of vapor molecules in the bubble of
steam (much enlarged) creates a gas pressure (called the vapor pressure) that counteracts the atmospheric and water pressure against the bubble. Objects float because a buoyant force acts on them. The balloon and the oppositely charged part of the door are attracted and the balloon sticks. What concept was missing from people's minds in the 16th
century when they couldn't believe Earth was moving? Can a star also go through multiple supernovae? Compared to the distance of an object in front of a plane mirror, how far behind the mirror is the image? LEARNING OBJECTIVE Distinguish between transverse and longitudinal waves. The magnet and the paper clip pull equally on each other to
make up the single interaction between them. Mineral B, because lowsilica minerals are the last to melt. Because the amplitude of its vibration. Then consider the distance d the rocket would travel during this brief burst at the apogee and
at the perigee.) 118 PARTONEPHYSICSREADINEST ON EPHYSICSREADINEST (RAT) If you have a good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. Directly above the focus is the epicenter, the point on Earth's surface where most of an earthquake's energy does its damage.
Energy, on the other hand, is abstract. Write a balanced equation for this reaction. The pressure of the atmosphere, with nothing inside pushing back, crushes the can. Why do we use the pH scale to indicate the acidity of a solution rather than simply stating the concentration of hydronium ions? The buoyancy in both cases is numerically equal to the
weight of fluid displaced. Potential energy The energy that matter possesses due to its position: Gravitational PE = mgh Power The rate of doing work (or the rate at which energy is expended): Power = work time Precambrian time The time of hidden life, which began about 4.5 billion years ago when Earth formed and lasted until about 543 million
years ago (beginning of the Paleozoic), and makes up almost 90% of Earth's history. The water levels are equal whether the ends are held close together or far apart. The nail becomes warmer. Give an example. This is in accord with Ohm's law. Likewise, the hypothesis "Intelligent life exists on other planets somewhere in the universe" is not
scientific. So your atoms then become a part of us, just as the atoms we exhale eventually become a part of you! 12 C H A P T E R 1 2 Atoms and the Periodic Table W e humans have long tinkered 12. At first thought, this may seem surprising—perhaps because we usually associate boiling with heating. 4.7 Circular Satellite Orbits 24. And when the
barbell is held stationary, no further work is done and there is no further change in energy. Some minerals have the same combination of elements, but their atoms are arranged differently, which makes them different minerals. Fossils record the evolution of life. Heat exchanger (boiler) Fuel rods Turbine Generator Condenser Water pumps
we find clear skies and fair weather. What is the age of the Sun? If 80.0% of the atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, what is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate atomic mass of 82.00 amu, which is the approximate 
TUTORIAL: Atomic Structure VIDEO: Evidence for Atoms VIDEO: Atoms Are Recyclable LEARNING OBJECTIVE Recognize the elements of the same brightness. The rigid walls of the tire prevent the pressure calculations from being
closer. (d) How do your calculations support the importance of stepping voltages up with transformers for long-distance transmission? From the surface of this planet, would you expect to see a white Sun? Cool air wants to sink. The nearest star to our Sun is Alpha Centauri, which is about 4.4 light-years away. Once you feel comfortable with staying
with your breath, you can practice welcoming in a particular thought, which becomes your focus while your breathing recedes to the background. These lines are very low in resistance and are connected to wall outlets in each room—sometimes through two or more separate circuits. Which one is greater? Note that the heat of vaporization of ethyl
alcohol Lv (200 cal/g) is 2.5 times greater than the heat of fusion of water (80 cal/g), so in a change of phase for both, 2.5 times as much ice will change phase; 2.5 * 4 kg = 10 kg. This energy, whether it is the energy that is absorbed as a bond forms, is called bond energy. (c) is a scientific hypothesis and
late fall nighttime sky. All the quantities—m1, m2, F, and d—were known, from which the constant G was calculated: G = F = 6.67 * 10-11 N/kg2/m2 = 6.6
suggesting that the carbon within the center of many white dwarfs crystallizes into diamond. How do these questions relate to the direction of heat flow? This is why Jupiter is the largest of the outer planets. Two horizontal forces act on it. Smaller molecules, because they experience fewer attractions to their neighbors, condense only at the cooler
temperatures found at the top of the tower. Hewitt 685: Shutterstock 691: (a) Shutterstock 691: (b) iStockphoto 691: (c) iStockphoto 691: (d) Shutterstock 691: (e) iStockphoto 6
1980. This results in a water temperature that is higher than the normal boiling point. Vector quantities may be represented by arrows. A B C 46. 316 PA R T T W O CH E M I S T RY Periodic table A chart in which all the known elements are listed in order of atomic number. If you find that half of 1000 people born in the year 2000 are still living in
2060, does this mean that onequarter of them will be alive in 2120 and one-eighth of them alive in 2180? How about polar molecules? Sulfur's practical limit is 88 and nitrogen's limit is around N12. The direction of the wind impact force on the sail is not in the direction of the wind impact force on the direction of the wind impact for
and radial distance r, the direct proportion of v to both r and v becomes the exact equation v = r v. The mantle boundary to the base of the crust. Here's a situation to challenge you and your friends. The rules of color subtraction differ from the rules of light addition. You can even peel muscovite off in thin layers. We
shall explore chemical bonds and the reactions in which they are formed and broken in Chapters 15, 17, and 18. Three blocks of metal at the same temperature are placed on a hot stove. Dig into your penny collection and find 20 pre-1982 and 20 post-1982 pennies. Newton's third law? It pivots about the slowermoving left wheel because it travels
farther in the same time. What is the chemical formula for the compound typically contains a multitude of ions grouped together in a highly ordered three-dimensional array. Thus, we can see that the nebular theory accounts for the formation of the
planets and the neat division of them into two groups. This decreases the current in the circuit and therefore in each lamp, which causes dimming of the lamps. For example, if a vehicle travels at 60 km/h, we know its speed. If not from the stars, where did this helium come from? Show that there are 1.0 * 1022 carbon atoms in a 1-carat pure diamond
 that has a mass of 0.20 \text{ g}. (All colors are combined by the addition of light.) Red + green + blue = white Red + green = yellow = white roughlest blue = magenta = white roughlest blue = white roughlest blue = white roughlest blue = magenta = white roughlest blue = compressed to an infinitely small size, which
you would not survive. How many grams of gallium are there in a 145-g sample of gallium are there in a 145-g sample of evaporite mineral. What is the solar wind? Why does a sudden downward yank break the bottom string while a slow pull breaks the top string? F 2 * This is a
 dramatic example of the painstaking effort and cross-checking that go into the formulation of a scientific theory. The classic example is photosynthesis, which is an endothermic reaction in which plants use solar energy to create carbohydrates and oxygen from carbon dioxide and water, as represented by this equation: Sunlight + 6 CO2(g) + 6
H2O(g) h C6H12O6(s) + 6 O2(g) Carbon Water Carbohydrate and oxygen products, which, of course, are the primary fuels of living organisms (Figure 17.21). Would its exhaust heat the surrounding air? This is because the input force is exerted
through a large distance and the load is moved through a correspondingly short distance. Combustion reactions are characteristically exothermic (energy-releasing). .Ga ... So if we cool the 100C solution to 20C, 78 g (165 g - 87 g) precipitates, as shown in Figure 16.21. The funnel confines the water, which is forced up the tube and driven out at the
top. It goes into work done on the surrounding air as the expanding air pushes outward. Science greatly advanced when Galileo favored (a) philosophical discussions over experiment. Primary effluent Aeration tank In Hong Kong, about 80% of all toilets flush using seawater. FIGURE 18.2 (b) (a) (c) (d) Examples of bases. When a solution has a
hydroniumion concentration of 1 M, the pH is 0 because 1 M = 100 M. Manufacturers claim that ionized bracelets relieve such pain. 3 5 This two-dimensional composition shows the approximate relative distances between the members of our Local Group of galaxies. Tall stack! FIGURING PHYSICAL SCIENCE Calculating for Solutions From the
formula for the concentration of solution, we can derive equations for the amount of solution = amount of solution
the units must always match. What mainly determines a rock's initial melting temperature? (d) In order for two substances to be soluble in each other, their molecules need to be of comparable mass. Gunpowder was wetted with a beverage of suspect alcohol content. The solubility of a gas decreases with increasing temperature because the gas
molecules have more kinetic energy and are more likely to escape from solution. (b) When the bottle is opened, the rate at which carbon mouth, which abounds in nucleation sites. The cones in your retina that are receptive to the color of the paper become
fatigued, so you see an afterimage of the complementary color when you look at a white area. How does the rotation of the Sun differ from the seeds from these trees were too large to be distributed by wind, the wide distributed by wind, the wind a wind
the continents were once joined together. Yuck! Why Sunsets Are Red Light that is remains at very nearly the same temperature for many hours. Compare the advantages and disadvantages of electricity coming from a large central power station versus a
network of many smaller solar-based stations owned and operated by individuals. How many structural isomers are shown here? (c) Larger hydrocarbon chains tend to be branched. The acceleration of any object is a = Fnet/m, and Fnet in free fall = mg. Further, the balls gained the same amount of velocity in equal time intervals. Name at least two
ways that thermal energy in air can be decreased. Views of the Moon as seen from Earth 1 2 3 4 5 6 7 8 3 First quarter 4 2 Waxing crescent 6 Waning gibbous 7 Last quarter Sunlight always illuminates half of the
Moon. CHAPTER 1 PAT T E R N S O F M OT I O N A N D E Q U I L I B R I U M 19 One Kilogram Weighs 10 N A 1-kg bag of any material at Earth's surface has a weight of about 10 N (more precisely 9.8 N). 4 Metallic Bonds 15. The cover photo was taken in 2010 by physics author Paul's wife Lillian on a Li River cruise in China. The color red is seen
where the angle between a beam of sunlight and the dispersed light is 42°. (b) A = B = C. Placed side by side, these pennies would reach to the Andromeda galaxy, which is about a million light-years away. This change in color is a physical change.
12.4 The Periodic Table 10. How did density segregation contribute to Earth's internal layers? We can only wonder whether Pascal envisioned the extent to which his principle would allow huge loads to be so easily lifted. In the absence of air resistance, a ballplayer tosses a ball straight up. (b) An elderly person's are older because they have been
around much longer. LEARNING OBJECTIVE Relate volume and pressure changes for a confined gas. A car battery is actually a series of cells. The bottom-up approach involves building nanosized objects atom by atom. While you are setting up an experiment, a ball rolls off your lab table. Basaltic magma is still relatively low in silica—it is about 50% in sil
silica. The larger Kuiper belt objects, such as Pluto, have a fair amount of inertia and so are not so easily thrown off course. The oxygen molecule, O2, is an example. A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 28. View this slit at an oblique angle against a CD and look for spectral lines. For example, teeth and bone material contain the
mineral apatite. What is the name of the compound CaCl2? Condensation The change of phase from gas to liquid; the opposite of evaporation. (a) Does ball B roll faster along the lower part of its track than ball A rolls along its straighter track? This heat-generating process is occurring deep beneath your feet right now! Indeed, power from the atomic
nuclei is as old as Earth itself. Condensation occurs, leaving a very low pressure in the can, whereupon the surrounding atmospheric pressure crunches the can. The density of ice at any temperature is much lower than the density of water, which is why ice floats on water. 2 m/s A 4 m/s B 6 m/s C E X E R C I S E S (SYNTHESIS) 62. E X E R C I S E S
(SYNTHESIS) 17. The sugar molecules in the teaspoon of sugar in Figure 16.4, for example, are identical to the sugar molecules already in the teas to nenclosed gas in the tube. 11.4 Refraction 12. This is more than the
number of breaths in Earth's atmosphere. 12.6 (b) Identifying Atoms Using the Spectroscope EXPLAIN THIS How is it possible to tell what stars are made of when they are so very far away? Astronomy relies on discoveries made using advanced technologies, such as space telescopes. The atmospheric pressure at Jupiter's rocky surface is more than a
million times the atmospheric pressure of Earth. 3 0 Color depends on the light source. (b) actually increases. Extended time means less force in the impulse that brings the egg to a halt. If a permanent magnet is dropped or heated outside the strong magnetic field from which it was made, some of the domains are jostled out of alignment and the
magnet becomes weaker. Strong electromagnets are used to control charged-particle beams in high-energy accelerators. Nonmetal PERIOD I C Tof AB L EElements OF THE ELEMENTS Periodic Table the Hewitt nceptual Physical Science 1 1 PHYSICAL CONSTANTS Name Speed of light Planck's constant Symbol c h Gravitational constant Charge of
 electron Mass of electron G e me Mass of proton mp Mass of neutron mn Avogadro's number NA Unified atomic mass unit u Value 2.9979*10-34~\mathrm{J} # s 4.1356692*10-34~\mathrm{J} # s 4.1356692*10-31~\mathrm{Kg} 2.602*10-31~\mathrm{Kg} 2.9979*10-31~\mathrm{Kg} 2.9979*10-31~\mathrm{Kg}
939.56563 MeV 6.0221367 * 1023/mol 1 mole = 6.022 * 1023 particles 1.6605402 * 10-27 kg 931.49432 MeV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's orbit Mass of Moon Radius of Moon Radius of Moon's orbit Value 9.81 m/s20 meV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's surface, g Mass of Sun Radius of Moon Radius of Sun Radius of Sun Radius of Moon Radius of Moon's orbit Value 9.81 m/s20 meV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's surface, g Mass of Sun Radius of Moon Radius of Moon's orbit Value 9.81 m/s20 meV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's surface, g Mass of Sun Radius of Sun Radius of Moon Radius of Moon Radius of Moon Radius of Moon Radius of Moon's orbit Value 9.81 m/s20 meV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's surface, g Mass of Sun Radius of Moon Radius of Moon's orbit Value 9.81 m/s20 meV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's surface, g Mass of Sun Radius of Moon Radius of Moon's orbit Value 9.81 m/s20 meV PHYSICAL PROPERTIES Name Acceleration of gravity at Earth's surface, g Mass of Sun Radius of Moon Radius of M
1.99*1030 \text{ kg } 6.96*108 \text{ m } 5.98*1024 \text{ kg } 6.37*106 \text{ m } 1.50*1011 \text{ m} = 1.50*1011 \text{ m} = 1.40*1036*1022 \text{ kg } 1.74*106 \text{ m } 3.84*108 \text{ m } CONVERSION FACTORS Length, Area, Volume 1 inch = 2.54 cm (exact) 1 ft = 30.48 cm (exa
acidic, they can be readily removed with an alkaline cleanser. This rule is called Pascal's principle: A change in pressure at any point in an enclosed fluid at rest is transmitted undiminished to all points in the fluid. His weight is 500 N, and the rope, unknown to him, has a breaking point of 300 N. Rather, they are brittle and shatter when hammered
Silicon 27.7 % Calcium 3.6 % Iron 5.0 % Aluminum 8.1 % Earth's Crust CHECKPOINT 1. Many sailboats sailing in directions other than exactly downwind (Figure B.16) with their sails properly oriented can exceed wind speed. 1 The Solar System and Its Formation 26. In an indirect sense, yes. C H A P T E R 18 T W O CL A S S E S O F CH EM I C A III CA III C
R E AC T I O N S 475 Disposable batteries have relatively short lives because electron-producing chemicals are consumed. We hope this will allow the instructor to reward those students who put time and effort into the Exercises. To answer this question we must consider the system involved. Nitrogen monoxide is transformed to nitrogen and
oxygen, carbon monoxide is transformed to carbon dioxide, and unburned fuel is converted to carbon dioxide, and unburned fuel is converted to carbon dioxide and the oceanic crust. Seismic waves can be amplified when they are
forced to slow down by certain soil and rock types. (a) Amethyst, the purple variety of quartz, has a hexagonal crystal form with pointed ends. TUTORIAL: Electric lightbulb, Thomas Edison stated that his trials were not failures, for he
successfully discovered 6000 ways that don't work. They noticed the effect of the finite speed of electromagnetic waves "with their own ears." FYI F I G U R E 11. These acids are carried by rain into the ground, where they transform into nitrate ions that plants use for growing—a process that involves further chemical reactions. Charge Polarization If
you charge an inflated balloon by rubbing it on your hair and then place the balloon against a wall, it sticks. In all the hydrocarbons discussed so far, including the methane shown in Figure 19.6, each carbon atom is bonded to four neighboring atoms by four single covalent bonds. This is a selfreinforcing wave that occurs as overlapping waves bounce
back and forth from thumb to thumb. Resonance The response of a body when a forcing frequency matches its natural frequency. Earthquakes Most earthquakes are related to Earth's tectonic movement. 235 U 238 U FIGURE 13.23 Only 1 part in 140 of naturally occurring uranium is U-235. Safely disposing of these waste products as well as
materials made radioactive in the production of nuclear fuels requires special storage casks and procedures. * The Moon actually orbits Earth once every 27.3 days relative to the stars. This is matter made of protons, neutrons, and electrons, which includes the atoms and molecules that make us and our immediate environment. Three essential bits of
initial PEs of the balls relative to the ground below, (b) initial KEs of the balls when tossed, (c) KEs of the balls when they bit the ground below, and (d) times of flight while airborne. REVIEW 209 8.7 Electrical Resistance 20. We once viewed the constellations as heavenly gods. (b) Polaris. In between, there is a particular radius at which photons can
orbit the black hole. 7-15 Peak Dates Meteors per Hour Jan. But the atmosphere is opaque to high-frequency ultraviolet light. (a) Earth's materials separated early in its history through the process of density segregation. His research team measured both the distances and redshifts of numerous galaxies and discovered that the farther the galaxy, the
 lines.) The wavefronts are everywhere * Just how much the speed of light differs from its speed in a vacuum is given by the index of refraction, n, of the material: speed of light in vacuum n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s, and so the index of refraction for diamond is n = 1.4,000 km/s.
Universal Gravitation 4. Furthermore, these reactions are better suited to maintaining a given voltage during longer periods of operation. We have learned that silica content is a key factor in a mineral's melting point. The extra time is equal to the time it takes to cool to the initial temperature of the lukewarm cup of tea. Products The new materials
formed in a chemical reaction. Our world can be studied at different levels of magnification. The energy we require to live comes from the chemically stored potential energy in food, which is transformed into other energy forms during the metabolism process. Nitrogen, N2. Tell how your bucket swing is like satellite motion—that satellites in orbit
continually fall toward Earth, but not with enough vertical speed to get closer to the curved Earth below. Constant speed and c
Observatory Publications Office 751: Julian Baum/New Scientist/ JPL/Photo Researchers, Inc. What's inside the open spaces of the ice crystals shown in Figure 6.19? But when you bring a magnet nearby, they can be induced into alignment. They flap them forward and backward, with a tilt that provides an angle of attack. A can of diet soda floats in
standing on the Moon when this photo was taken, you would see your faint shadow cast by the fully lit Earth shining above you. An average apple weighs 1 N. After tossing them once again, remove all coins landing tails-up. Thus, atmospheric hydrogen chloride mixes with atmospheric moisture and precipitates with rain. Cetyl alcohol, C16H34O, is a
 common ingredient of soaps and shampoos. Speed is somewhat different from velocity, and acceleration is vastly different from speed or velocity. 6 Polar Covalent Bonds 15. One monomer is adipic acid, which contains two reactive end groups, both carboxyl groups. Dark matter is invisible to the electromagnetic force, which is what holds us up off
the ground. The mass of a star is the principal factor that determines its fate. ether 9. 25.4 Air Masses, Fronts, and Storms In the Northern Hemisphere, why does a cyclone have a counterclockwise rotation? Show that the force between them becomes 25 times as strong. Rather than reading chapters in this book slowly, try reading quickly and more
than once. REVIEW 733 Oort cloud The region beyond the Kuiper belt populated by trillions of icy bodies and a source of long-period comets. What pressure would you expect in a rigid container of 0°C gas if you cooled it to - 273°C? FIGURE 12.2 Was this your answer? Similarly, we live at the bottom of our ocean of air and look upward at balloons
 and other lighter-than-air objects drifting above us. Break these in half, and you have four magnets, each with a north and south pole. What do you observe? If we pass sunlight through a prism and then place the petal of a deep-red rose in various parts of the spectrum, the petal appears brown or black in all regions of the spectrum except in the red
region. To pull a wagon across a lawn at a constant velocity, you must exert a steady force. Which of the boxes above best represents a compound? If an atom has only one or a few electrons in its valence shell, it tends to give up (lose) these electrons so that the next shell inward, which is already filled, becomes the outermost occupied shell. Rub halfactorial tends to give up (lose) these electrons in its valence shell inward, which is already filled, becomes the outermost occupied shell.
of the hanging straw with a piece of wool. The sequence for total distances covered is of the squares of the time. Furthermore, the molecules, behaving as a fundamental unit, may have electrical attractions explain
subducted at convergent plate boundaries, whereas continental crust is not subducted—it remains at Earth's surface. It is called the telescope. Many detergents today contain sodium carbonate, Na2CO3, commonly known as washing soda. It makes no difference how deep the cube is placed, because, although the pressures are greater with
increasing depths, the difference between the pressure up against the bottom of the cube and the pressure exerted downward against the top of the cube and the pressure at any depth (Figure 5.13). Consider an ant on a balloon. Thus, if a reflector is oriented so that you can see a particular musical instrument, rest assured that you can also hear it. Give
two reasons for the slowing of the cart, one in terms of a horizontal force acting on the cart and one in terms of momentum conservation. 75° 60° 45° FIGURE 4.20 Maximum range would be attained when a ball is batted at an angle of nearly 45°—but only in the absence of air drag. 38. (Think carefully. From then to perhaps 101000 years
in the future, the wavelengths of photons as well as all other remaining particles will be stretched to the lowest energy by the freezing water keeps the temperature of the cellar from going below 0°C. Yet few theories have affected science and civilization as much as Newton's theory of gravity. Note
 that this answer can be obtained by looking only at the relative positions of these elements in the periodic table rather than by calculating the differences in their electronegativities. The measured speeds tell us that the masses of these galaxies are many times greater than the total mass of all their stars. In 1962, magnetic surveys of the Atlantic
basin began, with results quite similar to those found in the Pacific basin. Neighboring galaxies will then be pulled out of each other's sight. In a longitudinal wave? For this course, all you need to do is be familiar with what stoichiometry is all about, which is keeping tabs on atoms and molecules as they react to form products. Hydrogen can be
obtained via solar cells, many along train tracks and on the rail ties themselves (Figure 3.35). Robberto (Space Telescope Orion Treasury Project Team 713: (top) SOHO (ESA & NASA) 713: (bottom) Jerry Lodriguss/ Photo Researchers, Inc. Two external forces acting on the same object, even if
they are equal and opposite in direction, cannot be an action-reaction pair. Show that the resulting nucleus is neptunium-239. Fahrenheit (1686–1736). The slight tingle you feel and the metallic taste you experience result from a slight current of electricity pushed by the citrus cell through the wires when your moist tongue closes the circuit. The
greater the value of a, the greater the change in length for a given change in temperature. The energy released by the fission of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the fission of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy released by the explosion of one U-235 nucleus is relatively enormous—about 7 million times the energy relatively enormous—about 8 million t
neighboring Ping-Pong balls. Hold a stone above your head!) and drop it. Both a potassium atom are in group 1 of the periodic table. He studied medicine at the University of Pisa and then changed to mathematics. Propose an explanation involving the relationship between reaction speed and the
frequency of molecular collisions. The divisions are based on changes in life forms. Keep in mind that each carbon atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have four covalent bonds, each fluorine and hydrogen atom must have fluorine and hydrogen at
spool is pulled horizontally to the right, in which direction will it roll? Special theory of relativity The theory first proposed by Einstein discussing the effects of uniform motion on space, time, energy, and mass. How might these laws have been different if our solar system was surrounded by a thick halo of dark matter? Officials in these countries point
out that the supplies of naturally occurring U-235 are limited. Just as water cools to form ice, magma cools and solidifies to form the minerals that eventually become rock. Be . In the U.S. heat has traditionally been measured in calories, another measured in calories, and another measured in calories, a
than in cold water. f, e, d, b, c, a. Note that the sodium ion is smaller than the sodium atom because the lone electron in the third shell has gone once the ion forms, leaving the ion with only two occupied shells. As the world population increases, so does our need for energy, especially because per-capita demand is also growing. Thermal pressure
halts further gravitational contraction until all the carbon is fused. Light atomic nuclei are most stable when composed of equal numbers of protons and neutrons, as discussed earlier, and heavy nuclei need more neutrons than protons for stability. A salt bridge may be as simple as a paper towel soaked in salt water. Some exceptions are low-melting
point metals, such as lead. Astronomers prefer to view the stars when the Moon is absent from the night sky. The most abundant mineral in the crust is feldspar, a nonferromagnesian silicate that contains aluminum, sodium, potassium, and/or calcium, plus silicon and oxygen. Frequency is the rate of vibration of a wave source. How about a solid
changing into a liquid? (Turn off the burner before the water is all gone. Why, then, aren't all materials magnetic? b Choose the BEST answer to each of the following. It does, just as another person leaning against you would. Acid rain is created when airborne pollutants, such as sulfur dioxide, are absorbed by atmospheric moisture. Two common
oxidation-reduction reactions involving oxygen as the oxidizing agent are corrosion and combustion. FIGURE 10.5 INTERACTIVE FIGURE v = 1 m/s 1m CHECKPOINT 1. This occurs, for exη Mħ Mħ η ample, when molten gold and molten palladium are blended to form a homogeneous solution known η Mħ η ample, when molten gold and molten palladium are blended to form a homogeneous solution known η Mħ η ample, when molten gold and molten palladium are blended to form a homogeneous solution known η Mħ η ample, when molten gold and molten palladium are blended to form a homogeneous solution known η mħ η ample, when molten gold and molten palladium are blended to form a homogeneous solution known η mħ η ample, when molten gold and molten palladium are blended to form a homogeneous solution known η mħ η ample, when molten gold and molten g
Temperature NaNO3 Solubility (grams of solute in 100 mL of water) You probably know from experience that water soluble solids usually dissolve better in hot water than in cold 180 water) You probably know from experience that water-soluble solids usually dissolve better in hot water than in cold 180 water. Explain how they could convince their tea-time friends of this intriguing concept. For example, in Denver, Colorado, the "mile-high city," water boils at 95°C
instead of at 100°C. Acceleration refers to a change in velocity. This is because the forces act on different masses. Mars orbit Me S un bit Earth orbit us orbit Ven recury or Solar System Our home planet Earth resides within the Sun's habitable zone, which is a region not too close and not too far from the Sun so that water can exist predominately in
the liquid phase, as shown in Figure 26.11. It was argued that this would be impossible if Earth were moving. 79. A nonmaterial container is a magnetic field that can exist at any temperature and can exert powerful forces on charged particles in motion. Shale, sandstone, and conglomerate. In order for you to receive a shock, there must be a
difference in electric potential between one part of your body and another part. 2 0 h182 kJ/mole Reactants Reaction progress Products In an endothermic reaction, the product molecules are at a higher potential energy than the reactant molecules. This includes the addition of dissolved oxygen, which as shown in Table 16.1, can be no more than
to a proton by emitting an electron. As shown in Figure 19.23, a carboxylic acid transforms to a carboxylate ion as it loses the hydrogen ion. 28.6 The Fate of the Universe 26. FYI 46 PA R T O N E P H Y S I CS When Galileo allegedly dropped objects of different weights from the Leaning Tower of Pisa, they didn't actually hit at the same time. As we
discussed in Section 16.3, this is the point of saturation, and any additional sucrose added to the solution Sucrose does not dissolve. State Newton's second law. Its atoms are as unordered as those in ordinary window glass. Area A Area 50 A FIGURE 5.31 A 10-kg load on the left piston supports 500 kg on the right piston. 6 202 20 A 08 Aug. The more
slowly an electron moves, the more its behavior is that of a particle with mass. The glare from glass or water is a good example. Because the dates of pole reversals can be determined by dating ocean-floor rock, the rate of seafloor spreading can also be determined. Thus, carbonic acid neutralization in the ocean prevents CO2 from being released
back into the atmosphere. What type of reaction occurs at the cathode? (a) There is now a higher concentration of dissolved CO2 in the water. The inverse-square law tells us that the brightness of a star is related to the inverse distance to the star squared: 1 2 Apparent brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the inverse distance to the star squared law tells us that the brightness of a star is related to the star squared law tells us the star
1 2 Apparent brightness of star A \phi ¢ \leq = 1 1 1 2 Apparent brightness of star B \phi ¢ \leq = 0.25 2 771 The North Star, also known as Polaris, is a Cepheid variable with a period of about four days. Measuring out 20 times as much mass of golf balls as Ping-Pong balls, therefore, gives equal numbers of each, as is shown in Figure 17.2. F I G U R E 17. Did
tension in his rope increase as I moved closer? Stay tuned for science news reports. The negatively charge of calcium and magnesium ions than to the single positive charge of sodium ions. (c) decreased insulation. As with Sample Problem 1, the
time t of the ball in flight is the same as if we had just dropped it from rest a vertical distance y from the top of the net. What is the impact speed when a car moving at 100 km/h collides with the rear of another car traveling in the same direction at 98 km/h? The chloride ion is larger than the chlorine atom because the addition of that one electron to
the third shell makes the shell expand due to the repulsions among the electrons. Noise-canceling devices such as jackhammer to the jackhammer operator by means of earphones are you ever noticed on a major that is out of phase with the sound of a noisy jackhammer to the jackhammer operator by means of earphones. ave you ever noticed on a major that is out of phase with the sound of a noisy jackhammer to the jackhammer operator by means of earphones. ave you ever noticed on a major that is out of phase with the sound of a noisy jackhammer operator by means of earphones.
that Africa and South America fit together like pieces of a jigsaw puzzle (Figure 21.10)? The decomposition of food by bacteria in our digestive system is primarily anaerobic because little oxygen makes it from our mouths to our intestines where food decomposition takes place. Obsidian is a kind of glass formed in volcanoes. (a) 60 cycles per second
or 60 Hz; (b) 60 second. Like sound from the bells, the re-emitted light is sent in all directions. Infrared and red light are absorbed by water. What happens to the direction of the magnetic field when the current in the wire is reversed? On page 609 Emily uses a deck of cards to show how ice crystals slip
Hodge/Photolibrary/Peter Arnold, Inc. In this arrangement, a load can be lifted with half the input force. There are ten principal cloud forms, each of which belongs to one of four major groups (Table 25.2). State whether each of the following is a physical or chemical property of matter. We have the technology, for example, to extract fossil fuels from
the ground and then burn the fossil fuels to produce energy. The second monomer is hexamethylenediamine, in which two amine groups are the reactive end groups are the reactive end groups. What should be done with mining pits after all the ore has been removed? Which operates by way of buoyancy? In which will more heat be required to increase the temperature by 1°C?
The attraction became strong enough that the young Earth actually squeezed itself into a smaller volume, which produced even more heat. he age of microtechnology was ushered in some 60 years ago with the invention of the solid-state transistor, a device that serves as a gateway for electronic signals. Hydrogen chloride, HCl, does not stay in the
atmosphere very long because it is quite soluble in water, as can be deduced from its polarity (see Chapter 15). Defend your answers (and distinguish between velocity and acceleration). During the early history of the solar system, the young Earth had a Mercurysized companion form within an orbit close to that of Earth. Strong bases, for example,
tend to accept hydrogen ions more readily than weak bases do. (a) Nucleons close together Was this your answer? Sodium chloride is not sodium, nor is it chlorine; it is uniquely sodium chloride, a tasty chemical when sprinkled lightly over popcorn. Dirt may stick to it briefly, but after a few steps, the dirt sticks better to the surface on which the
gecko walks. Neon, Ne (atomic number 10), cannot attract any additional electrons. Show that the battery does 48 J of work. New Moon The phase of the Moon when darkness covers the side facing Earth. Mass number 56 Fe — Atomic symbol 26 Atomic number 10, cannot attract any additional electrons. Show that the battery does 48 J of work. New Moon The phase of the Moon when darkness covers the side facing Earth. Mass number 56 Fe — Atomic symbol 26 Atomic number 10, cannot attract any additional electrons.
number from its mass number: mass number at the highest point you can reach. When photographic film was in vogue, students replaced the tissue paper with unexposed photographic film, covering the back so it was
light tight, and covering the pinhole with a removable flap, all ready to take a picture. Particles in the smoke scatter predominantly blue light, so against a dark background you see the smoke as blue. For any battery, such as Membrane the one shown in Figure 18.24, the cathode is always positive (+), which indicates that electrons are natue n rally
attracted to this location. The first requirement is the presence of dust—the condensation nuclei discussed earlier in this chapter. VIDEO: Buoyancy Stick your foot in a swimming pool and your foot is immersed. Where does most of it appear in a hybrid vehicle? He returned to the Moon problem at the prodding of his astronomer friend, Edmund
Halley, for whom the second comet was later named. That must be why here on Earth the Moon appears red during a lunar eclipse! 26 C H A P T E R 2 6 The Solar System H ow does the Sun produce 26. A faster ball encountering the gap would hit the ground farther along the gap. EXPLAIN THIS A black hole is the remains of a supergiant star that
has collapsed into itself. This leads to the following statement of the first law of thermal energy h external work done by the system Suppose that you put an air-filled, rigid, airtight can on a hot plate and add a certain amount of thermal energy to the can. Electrical resistance is measured in units called
ohms. Near Earth's surface an object in free fall gains speed at the rate of 10 m/s each second, as shown in Table 1.2. Acceleration VIDEO: Free Fall: How Fast? The number of covalent bonds an atom can form is equal to the number of additional electrons it can attract
which is the number needed to fill its valence shell. When the barbell is accelerated upward, the force exerted by the athlete is greater than the weight of the barbell simultaneously pushes with greater force against the athlete. If the temperature of your forehead is a couple degrees higher than normal, then the temperature of your hand
is also a couple degrees higher. A bimetallic strip used in thermostats relies on the fact that different (a) specific heat capacities. (b) Thick zinc walls prevent electrons from being lost into the surrounding environment. Does this produce a current pulse? This question has yet to be resolved. C F I G U R E 1 .1 3 The table pushes
up on the book with as much force as the downward force of gravity on the tires and the road pushes back on the tires.
number play in the periodic table? Matter in the gaseous phase therefore occupies much more volume than it does in the solid or liquid phase. If a machine multiplies force by a factor of 4, what other quantity is diminished, and by how much? (b) With v0 being 0, d = 12 at 2 = 12 (4.0 m/s2)(15 s)2 = 450 m. Mauna Loa in Hawaii, the largest volcano on
 Earth, is a shield volcano standing 4145 m above sea level and more than 9750 m above the deep ocean floor (Figure 20.20). Light of higher frequencies stimulates the cones that are sensitive to higher frequencies and appears blue. When the mass of a moving object is doubled with no change in speed, by what factor is its momentum changed? First
look for changes in the ionic states of elements. They are familiar in solar-powered calculators, iPods, and flexible solar-powered shingles on rooftops. The naturally occurring isotopes U-238 and U-235 decay very slowly and ultimately become isotopes of lead—but not the common lead isotope Pb-208. When warm air moves into a cold air mass,
forming a warm front, the lessdense warmer air gradually rides up and over the colder, denser air (Figure 25.13). 97. C H A P T E R 16 REVIEW 421 R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 16.1 Most Materials Are Mixtures 1. As it sinks deeper and deeper into the water, does the buoyant force on it increase? It has bright
quantum effects. Distillation A purifying process in which a vaporized substance is collected by exposing it to cooler temperatures over a receiving flask, which collects the condensed purified liquid. 6 Identifying Atoms Using the Spectroscope 12. Can an accelerated frame of reference be distinguished from a gravitational field? CHAPTER 13 1. Hey
in this sense, we're all one! Gee, Bo, the atoms you exhale are the very ones both our baby sister Neve and I inhale. Which force, if either, is greater? It involves either the use of an electric current to produce an
Henry's time. Rank the following in order of increasing volume: (a) bacterium, (b) virus, (c) water molecule. Unfortunately, well-shaped crystals are rare in nature because of space constraints—most crystals grow in cramped spaces. Momentum Inertia in motion, given by the product of the mass of an object and its velocity. Controlling Fusion FIGURE
13.35 A cross-sectional view of the ITER (rhymes with "fitter") planned to be built and operating in Cadarache, France, before 2020. The excess carbon atoms would have no oxygen molecules to react with and would remain unchanged. Of this quantity, about 20 mg is the radioactive isotope potassium-40, which is a gamma ray emitter. Magnetic and
geographic poles don't match. The ground gets in the way, cutting off the view of a whole circular rainbow. (c) v = fl = fd = 0.5 Hz (1.8 m) The round trip is 2 s, meaning 1 s down and 1 s up. In some regions they are momentarily spread out (rarefactions). End of
 Chapter Content Available in MasteringPhysics All end of chapter problems are assignable within MasteringPhysics, including: t Multiple-choice versions of free response questions as they appear in the book, or automatically gradable multiple-choice versions t
 Interactive Think and Rank Problems t Plug and Chug and Think and Solve Problems that are algorithmically coded to provide each student with a unique problem t All end of chapter problems organized into a format following Bloom's Taxonomy in both the textbook and in MasteringPhysics MasteringPhysics® A TRUSTED PARTNER The Mastering
 platform was developed by scientists for science students and instructors, and has a proven history with over 10 years of student use. For perspective, this is about a tenth of the way to the Moon, which is about 300,000 km distant. Main sequence The diagonal band of stars on an H-R diagram; such stars generate energy by fusing hydrogen to
helium. "Foreign" molecules get in the way and interfere with crystal formation. How are they different from each other? The charge on a balloon rubbed on hair is typically much less than a millionth of a coulomb. Rank from greatest to least the total amount of charge on the pairs of spheres after separation. The speed of light is fast, but the universe
is exceedingly large. Modern gaseous anesthetics have fewer side effects than diethyl ether, but they operate on the same principle. A person can drown when breathing in water because it contains so little O2. Cosmic-ray particles streaming downward through the atmosphere are attenuated by radioactive decay and by absorption, so the radiation
and the ionization are stronger at high altitudes. When Wegener put South America and Africa together along their continental shelves, the fit was nearly perfect. However, as shown in Figure 26.10, Venus has a very dense atmosphere and opaque cloud cover that generate high surface temperatures (470°C)—too hot for oceans
If the upward force were the only force acting, the book indeed would rise. Many rivers and lakes receiving acid rain become less capable of sustaining life. (b) C, B, A. The presence of the S-wave shadow—no S-waves are found in this zone—indicates that the outer core is liquid. f light has both wave properties and particle properties, why can't a
material particle, such as an electron, also have both? The higher the frequency of the electrons. In such cases, gravity causes the shape of the galaxy to become distorted. No! Although the rate of cooling is greater for the hotter cup, it has further to cool to reach thermal equilibrium. G-7 Neutron An electrically
neutral subatomic particle of the atomic nucleus. The endothermic reaction, c, will likely take place slower than the exothermic reaction, a, because it requires a decrease in entropy. The pipe gets longer—and is also no longer snug. CHECKPOINT Coal contains tiny quantities of radioactive materials, enough that more environmental radiation
surrounds a typical coal-fired power plant. On page 140 another friend from college days, Dan Johnson, crushes a can with atmospheric pressure. The major difference is that the maximum coil rotation in a galvanometer is half a turn, whereas the coil in a motor (which is wrapped on an armature) rotates through many
day and cold at night, the walls of houses are often made of mud. Cost = (0.6 kWh)($0.080/kW # h) = $0.048, or about 5 cents. An iron block sinks, while the same quantity of iron shaped like a bowl floats. The faster one encounters greater air resistance. The definition of pH includes the minus sign so as to transform the logarithm of the hydronium.
ion concentration to a positive number. This is the same as saying 4 g of H2 reacts with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 6.02 * 1023 O2 molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O molecules react with 32 g of O2 to give 36 g of H2O or, equivalently, that 12.04 * 1023 H2O or, equivalently, equivalently, that 12.04 * 1023 H2O or, equivalently, equivalent
numerically equal to the voltage supplied by the source divided by
appreciably more voltage in the secondary. (Caution: The 1200-W label is valid only when 120 V is applied. The direction of thermal energy flow is from objects at higher temperatures to objects at lower temperatures. C H A P T E R 19 O R G A N I C CO M P O U N D S 503 FIGURE 19.20 O O C CH3 H3C (a) When the carbon of a carbonyl group is
bonded to two carbon atoms, the result is a ketone. Monomers The small molecular units from which a polymer is formed. Fiberglass is a good insulator principally because of the vast amount of air space trapped in it. Saturated hydrocarbon containing no multiple covalent bonds, with each carbon atom bonded to four other atoms. It
table. Show that her acceleration is 0.25 m/s2. S Scientists have a deep-seated need to know Why? In some parts of the world, progress is being made toward limiting human population growth, a serious threat that worsens almost every problem faced by humans today. The continents really do move—they move because they are embedded within the
drifting tectonic plates. There the water releases 4.19 J of energy for each gram of water that cools by 1°C. S edimentary rocks are the most common rocks in the uppermost part of the crust. FIGURE 5.44 The curved shape of an umbrella can be disadvantageous on a windy day. Therefore, you should be somewhat heavier at midnight and somewhat
lighter at noon." 107. In this sense it is used up. The three subtractive primary colors? By 5000 BC, pottery fire pits gave way to furnaces hot enough to convert copper ores to metallic copper. Igneous rocks formed from the cooling and crystallization of magma. What causes an atom to emit light? Hence, a glass of water evaporates more quickly on a
windy, warm, dry summer day. 11.3 Reflection EXPLAIN THIS W LEARNING OBJECTIVE Describe the law of reflection. 4. Because of these interactions, the edges of plates—the plate boundaries—are regions of intense geologic activity (Figure 21.21). Some radioactive isotopes have half-lives that are less than a millionth of a second, while others
have half-lives of more than a 1/4 kg billion years. If the wire is bent into another loop that overlaps the first, the concentration of magnetic field lines inside the loops is doubled. Data for the upper-level processes are needed Cold to understand why midlatitude cyclones form and progress. An object cannot possess impulse, just as it cannot possess
force. The balls have different masses and speeds. When one of the forks is struck, it sets the other fork into vibration. All rocks, whether igneous, sedimentary, or metamorphic, can undergo metamorphism. In another chemical reaction, two hydrogen gas molecules, H2, react with one oxygen gas molecule, O2, to produce two molecules of water,
H2O, in the gaseous phase: 2 H2(g) \geq 1 O2(g) (balanced) * For all practical purposes this law holds true. All the rocks and bits of matter that make up the rings pursue independent orbits about Saturn. This force can provide recoil toward shore. FYI CHECKPOINT Isn't it common sense to think that Earth is in its proper place and that a
force to move it is inconceivable, as Aristotle held, and that the Earth is at rest in this universe? Answers to RAT 17 C H A P T E R 1 7 How Chemicals React 17. A double covalent bond between two carbon atoms FIGURE 19.30 Another important addition polymer is polyvinyl chloride (PVC), which is used to fabricate many household items. 130 PA R T
ONEPHYSICS 10,000 kg, b, a, c, d. When our Sun reaches the giant stage about 5 billion years from now, its swelling and increased energy output will escalate Earth's temperatures. Figure 5.8 shows why the buoyant force acts upward. 5 Losing and Gaining Electrons 18. So something painted red absorbs cyan, which is why it reflects red.
Stating it another way, \boxtimes F = 0. The difference is that a beta particle originates inside the nucleus—from a neutron. Without air resistance, a ball tossed at an angle of (a) 45°. 3 Conduction of heat from Lil's hand to the wine is minimized by the long stem of
the wine glass. In 1954, Pauling won the Nobel Prize in Chemistry for his research into the nature of the chemical bond. This speed is added to the launch speed of a satellite and thereby saves fuel. Heat gained by cool water = heat lost by warm water cm1 ©T1 = cm2 ©T2 SAM PLE PROBLEM 1 F I G U R E 6.11 Here we have different masses of
water that are mixed together. The negative charge of the phenoxide ion, however, is not restricted to the oxygen atom. FIGURE 15.39 Because the normally even distribution of electrons in atoms can momentarily become uneven, atoms can be attracted to one another through induced dipole-induced dipole-induc
suspension is clouds, which are homogeneous mixtures of tiny water droplets suspended in air. It seemed that either the magnetic poles migrated through time or the continents had drifted. (b) longitudinal. Thermal energy is normally measured in units of (a) calories. FYI Meitner, received the Nobel A typical uranium fission reaction is Prize for the
work on nuclear fission. The actual voltage in a 120-V ac circuit varies between +170 V and -170 volts, delivering the same power to an iron or a toaster as a 120-V ac circuit. Notably, about half of these interstellar molecules are carbon-based organic molecules. Earth absorbs short-wavelength radiation from the Sun and reradiates it as long-
wavelength terrestrial radiation. The ocean floor moves in a conveyor-belt fashion, with new lithosphere formed at a spreading center and older lithosphere pushed from the ridge crest to be recycled back into the mantle at a deep ocean trench. Simply reverse the wire inputs to one of the speakers so that the two are out of phase. The covalent bonds
in a carbon dioxide molecule, for example, are many times stronger than any forces of attraction that might occur between two adjacent carbon dioxide molecules. At the first quarter, the angle between the Sun, the Moon, and Earth is 90°. 6 Dispersion 11. For this reason, the opening to any cavity appears black to us. But some reflects from its
surface. Isn't this contradictory? Show that your weight would be 19 its present value. It is seen near the Sun at sunup or sunset. Refraction The bending of a wave, either through a nonuniform medium to another, caused by differences in wave speed. The ions in solution are replenished by the forced oxidation of the coating
metal at the positive electrode. TA B L E 1 6. These are physical changes. B A C 120. Why do you lurch backward when it picks up speed? To calculate for pH: pH = -\log (0.05) = -(-1.3) = 1.343. Take this into account to balance this chemical equation: Sn2 + Ag h Sn + Ag + 77. To lose weight, the person could go to the top of a
mountain where the force of gravity is less. This is true for the interiors of all metals that carry static charge. Make a mark on the wall at the top of your reach. Furthermore, the tungsten becomes unstable and splits from the halogen when it touches the hot filament. The physical property we call density has changed with temperature, but the identity
of the substance remains unchanged: mercury is mercury. Its molecules are close together and greatly resist compressive forces, so liquids, like solids, are difficult to compress. Because the buoyant force upon a body equals the weight of the fluid it displaces, denser fluids exert more buoyant force upon a body than less-dense fluids of the same
volume. Why is sodium chloride, NaCl, insoluble in gasoline? Most people see them to be about the same size, while many see the nearer hand as slightly bigger. Between oppositely charged parallel plates, the electric field is uniform. The ear recognizes the different sounds produced by a piano and
a clarinet. Estimate the answer vourself. We can observe its gravitational effects on objects in the space surrounding it. Many people hear about atmospheric ozone depletion and wonder why we don't simply replace the ozone that has been destroyed. These are called the jovian planets because their large sizes and gaseous compositions resemble
those of Jupiter. F I G U R E 1 0 .1 The relationship between a vibration and a wave is shown in Figure 10.1. A INTERACTIVE FIGURE marking pen on a sheet of paper that is moved horizontally at constant down, a marking pen traces out
speed. In this reaction, which is still used today, each fat molecule is broken down into three fatty acid soap molecules and one glycerol molecules, forming what is called a micelle. Hewitt 140: Paul G. Newspapers everywhere announced the discovery as
one that measured the mass of the planet Earth. (c) more than 5 m/s. At five times the distance, the force 1 decreases to 25 of its original value. (d) forms into clouds. The snow-covered mailboxes raise a question: What physics explains why the light-colored ones are snow covered, while the black ones are free of snow? Compare the distances fallen
with those given in Table 1.2 in Chapter 1. The ranges are relatively narrow because most of the deformation related to plate interaction does not propagate far from the plate boundary. This cycle—essentially a natural heat engine—continues unless strong, upper-level winds from outside the storm disrupt the upward flow pattern, or the hurricane
moves over land. The nighttime sky is full of more than just stars and planets. Quickly remove P L U G A N D C H U G (F O R M U L A FA M I L I A R I Z AT I O N) Pressure g weight density: depth (Neglect the pressure due to the atmosphere in the calculations below.) 47. In the vicinity of the high (H on a map), we see clear skies. Even the drifting
of continents (see Chapter 22) is related to Earth's internal radioactivity. The atomic spectrum is an element's fingerprint. See also Radiant energy; Radiation by sublimation, 174 in thermos, 172 Heat waves, 265 Helium, abundance of, 774 Hertz, 239 Hertzsprung-Russell diagram, 743-744 Heteroatoms, 496 Heteroatoms, 496 Heteroatoms, 400 High clouds,
690-691 Holocene epoch, 637, 640-641 Homogeneous mixtures, 400 Hubble's law, 772 Humidity, 683-686 Hurricanes, 700-701 forecasting of, 701-703 Hydrologic
cycle, 590-591 Hydronium ions, 456 Hydroxide ions, 457 Hypothesis, 3 I Ideal machines, 79 Igneous rocks, 533, 534-539 lava and, 536-538 I-4 INDEX Imaging acoustical, 246 magnetic resonance, 225 radioactive tracers for, 326 Impulse, 62-64 bouncing and, 65-66
momentum and, 63-66 Impure matter, 399-400 Inclusions, rock dating and, 621 Induced dipoles, 387-390 Induction electromagnetic, 225-227 field, 230-231 Inelastic collisions, 69 Inertia, 16-18 Galileo's concept of, 16-17 law of, 39-40, 52 mass and, 17-18 Inner planets, 709, 710, 714-718 Insolubility, 407 Instantaneous speed, 25 Interaction of
forces, 46 Interference, 248-251 Intrusive rocks, 539 Inverse-square law, 93-94 Ion(s), 371-372 attractive forces between, 386-390 dipoles and, 386-387. Light will pass through the filters when their axes are aligned, but not when their axes are aligned, but not when their axes are aligned, but not when their axes are aligned and in the solar law is a second to the filters when their axes are aligned and in the solar law is a second to the filters when their axes are aligned and in the solar law is a second to the filters when their axes are aligned and in the solar law is a second to the filters when their axes are aligned and is a second to the filters when their axes are aligned and is a second to the filters when their axes are aligned and is a second to the filters when their axes are aligned and is a second to the filters when the filters
system are shown in Table 4.1. Note that the escape speed from the surface of the Sun is 620 km/s. The large constellation Ursa Major (the Great Bear) is illustrated in Figure 27.1. The groupings of stars and the significance given to them have varied from culture to culture. A current above 20 amperes melts the fuse, which "blows out" and breaks
the circuit. Rather, they allow human waste to decompose aerobically (with oxygen) as air is vented over the waste, which is buried in peat moss. BITUMINOUS 4. Rotation begins in the middle of the thunderstorm and then works its way downward. So why don't we abandon fission energy, not to mention fossil-fuel energy, and just
use hydrogen? Similarly, most iron atoms (atomic number 26) have 30 neutrons, but a small percentage have 29 neutrons. Had the blast occurred within 50 light-years, most life on Earth would have likely gone extinct. See Stars Galvanometers, 223-224 Gamma rays, 323 Gases. Reactants . total distance covered Average speed = travel time Average
speed can be calculated rather easily. elting occurs when a substance changes phase from a solid to a liquid. As Figure 15.6 shows, each atom of any group 1 element, for example, has only one valence electron and so tends to form the 1 + ion. 20 PA R T O N E P H Y S I CS PAU L H E W I T T P E R S O N A L E SS AY When I was in high school, my
counselor advised me not to enroll in science and math classes but instead focus on what seemed to be my gift for art. What is the change in pressure? 300 PA R T T W O CH E M I S T RY FIGURING PHYSICAL SCIENCE Calculating Atomic Mass About 99% of all carbon atoms are the isotope carbon-12, and most of the remaining 1% are the heavier
isotope carbon-13. (b) poor conduction. As it rises, it cools, and water vapor condenses into a series of cumulonimbus or nimbostratus clouds. Consider "Newton's cannon" fired from a tall mountain on Jupiter. The canister is unsealed in the area to be sampled. If your course covers many chapters, your instructor will likely assign only a few items from
each. Peak frequency and absolute temperature are directly proportional; f & T. Show that the speed of the waves is slightly less than 1.0 m/s. All 24 pieces are mixed together to form a single group, which represents the magma before any minerals have formed. (b) Earth's gravity pulls down on a book. Now at upper levels, the cold conveyor
becomes incorporated into the westerlies. The most rapid changes, and the most violent ones, occur with three major types of storms: thunderstorms, tornadoes, and hurricanes. Mars Mars captures our fancy as another world, perhaps even as a world with life because it resides on the outer fringes of the habitable zone. A B REVIEW 115 (d) KE, (e)
PE, (f) total energy (KE + PE), and (g) acceleration. This is why the stubborn bolt shown in Figure A.9 is turned more easily when the applied force is perpendicular to the handle, rather than at an oblique angle, as shown in the first figure. CHECKPOINT Consider two parachutists, a heavy person and a light person, who jump from the same altitude
with parachutes of the same size. Use temperature and heat as examples. Note also that the units check, since 1 J/kg = 1 m2/s2 (1 J/kg = 1 m2/s2). Hewitt 292: Paul G. Sophia exerts a steady 40-N horizontal force on a 8-kg box resting on a lab bench. Chemistry is often called a central science because it touches all
of the sciences. The Mid-Atlantic Ridge is the divergent boundary between the North Atlantic, and the South Atlantic, and the South Atlantic Ridge is the divergent boundary between the Morth Atlantic, and the South Atlantic, and the South Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the divergent boundary between the North Atlantic Ridge is the Ridg
PHYSICS LEARNING OBJECTIVE Define support force, and explain its relationship to weight. This means that the outer-shell electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though it were 8 +, which is enough to hold the electrons experience the nucleus as though the nucleus as though the nucleus as though the nucleus as though the nucleus as the nucleus a
it completes a triangle between the spirals, is even closer to Andromeda, but farther away from us. When a lion tamer cracks a circus whip, the cracking sound is actually a sonic boom produced because the tip of the whip is traveling faster than the speed of sound. A chemist therefore need only convert these numbers of moles to grams in order to
know how much mass of each reactant he or she should measure out to have the proper proportions. The atoms of a given element emit only certain frequencies of light, however. In the late 1800s, this was done with our own star, the Sun. (Note: We speak here of the base-10 logarithm, not the natural logarithm of base e.) Any positive number,
including a very small one, has a logarithm. When the tape is moved past a small coil of wire, what happens in the coil? Sandstones CHAPTER 20 R O CK S A N D M I N E R A L S 543 form in a variety of environments, including dunes, beaches, marine sand bars, river channels, canyons, and underwater canyons—all places where moderateenergy
waters deposit similarly sized grains. Uranium-238 absorbs a neutron and then emits a beta particle. Best of all, learning these rules will provide a keener intuition for understanding the world around me! 1 C H A P T E R 1 Patterns of Motion and Equilibrium M ore than 2000 years ago 1. A number of objects at different temperatures placed in a
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closed room share radiant energy and ultimately come to 99. Unless an astronomer wishes to study the Moon, these dark nights are the best time for viewing other objects. Both 4°C water and rocks are more dense than water at any other temperature. Furthermore, the probe seems to be taking an unusually long time to descend. One set of diagrams
shows a physical change, and the other shows a chemical change. • The Pearson eText is available as a purchased upgrade online. To talk about what existed outside the Big Bang is meaningless. From 1943 to 1986, the FYI Hanford
nuclear facility in central Washington state produced 72 tons of plutonium, nearly two-thirds the nation's supply. Dolphins can "see" physical evidence of cancers, tumors, and heart attacks—which humans have only recently been able to detect with ultrasound. (a) Citrus fruits contain many types of acids, including ascorbic acid, C6H8O6, which is
vitamin C. CHECKPOINT Correct the following incorrect statement: When a heavy element such as uranium undergoes fission, there are fewer nucleons after the reaction than before. Because the colliding plates have similar densities, neither sinks below the other—so in continental convergence there is no subduction. Given all these
different types of material, you might think that there must be many different kinds of atoms. Curb the source of soot emissions. Acceleration is always in the direction of the net force. Does the speedometer on a vehicle show average speed or instantaneous speed? When gravity gains full rein, the result is infinite density—a black hole. If a bedrock
outcrop is found that matches the rock type of an out-of-place boulder, then the distance and direction of glacial transport can be estimated. One benefit is an open and exploring mind. The rocks in the Layers get younger Axial plane Layers get older core of an anticline are oldest, and as you move horizontally away from the axis, the rocks get
younger. B. Nebular theory The idea that the Sun and planets formed together from a cloud of gas and dust, a nebula. Together, these ions make the ionic compound aluminum oxide, Al2O3, the (1) An electrically neutral sodium atom loses its valence electron to an electrically neutral chlorine atom. The current inside these and all other electrically
devices is regulated by circuit elements called resistors (Figure 8.25), whose resistance may be a few ohms or millions of ohms. Heteroatoms largely determine an organic molecule's "personality." C H A P T E R 19 TA B L E 1 9. While interiors of plates are relatively quiet, most earthquakes, volcanic eruptions, and mountain building events occur
where plates meet. Hewitt John Downer/Nature Picture Library Addison Wesley Longman, Inc./San Francisco John Lightfoot/Paul G. But gravity now is not felt as weight because there is no support force. Earth and the Moon are gravitationally attracted to the Sun. P L U G A N D C H U G (FORMULAFAMILIA
R I Z AT I O N ) These are "plug-in-the-number" tasks to familiarize you with the main formulas that link the physics concepts of this chapter. CHECKPOINT Suppose an archaeologist extracts a gram of carbon from an ancient ax handle and finds it one-fourth as radioactive as a gram of carbon extracted from a freshly cut tree branch. D I S C U S S I
ONQUESTIONS (EVALUATION) 96. As both wave shadow develops. (a) The wax near the flame melts. They are spherical, with the stars more crowded toward the center. Because silicon is much more abundant and less expensive to obtain, however, silicon
computer chips remain the industry standard. The cat leaves a trail of molecules across the yard. CHECKPOINT Which of these molecules is polar and which is nonpolar? When the voltage is lowered, the resistance of the toaster, not its power, remains constant.) T H I N K A N D R A N K (A N A LY S I S ) 63. (b) Show that ideally Art reaches a M
height h. Recall from Chapter 14 that only a chemical change involves the formation of new material. His body is very different from, say, the peanut butter sandwich he ate yesterday. Assume the illustrations above are two frames of a movie—one from before the reaction and the other from after the reaction. You also exert an impulse to catch a ball
These hydrogen bonds are strong enough to make sucrose a solid at room temperature and to give CH2OH it the relatively high melting point of 185C. What does the Moon have in 1978 and Magellan in 1993). Bubble your breath into the solution through
a straw until the pink color disappears. As shown in Table 15.3, there are four types of electrical attractions involving molecules. When the hydronium-ion concentration of a solution is 1 * 10-4 M, what is the pH of the solution? Sound from practically every musical instrument consists of a fundamental and partials. How does the mass of a bar of gold
vary with location? When the particle is released, what will be its kinetic energy as it flies past its starting position? Other physical properties that can help identify minerals are luster (the way a mineral reflects Basic structural light) and streak (the color of a mineral form in its powdered form). The formation of a mixture, therefore, is a physical
change. VIDEO: Free Fall: How Far? 12 Oct. Allow the can to stand. In terms of physics, why do restaurants serve baked potatoes wrapped in aluminum foil? The reason for special caution at the time of an eclipse is simply that more people are interested in looking at the Sun during this time. However, the body temperature of some animals, such as
the alligator shown in Figure 17.13, rises and falls with the temperature of the environment. CHAPTER 28 1. Once ejected, it is indistinguishable from an electron in a cathode ray or electrical circuit, or one orbiting the atomic nucleus. Why is
water so difficult to purify? Tensional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks, are the opposite of compressional forces, which pull at rocks are the opposite of compressional forces, which pull at rocks are the opposite of compressional forces.
by a bug swimming at wave speed. Explain how a convection cycle is generated. The fundamental unit of Molecules are the fundamental unit of Molecu
Note that the vector diagram suggests that pushing the wheelbarrow may not get it over the step at all. What is its new resistance when it is shortened by (a) cutting it in half, and (b) doubling it over and using it as if it were one wire of half the length but twice the cross-sectional area? The path was paved for Isaac Newton to make further
connections of concepts of motion. Rather, it causes certain insects, especially mosquitoes, to lose their sense of direction, which effectively protects DEET wearers from being bitten. (b) Sandstone and limestone are sedimentary rocks. Condensation releases heat, which draws moist air upward from the ocean surface. ating elevator? We call this
speed of light c.* The speed of light in the atmosphere is slightly less than it is in a vacuum, but is usually rounded off as c. Cousin George Webster is seen with his scanning electrons from one reactant to another. FIGURE 2.2 Examples of inertia.
Carboxylic acid An organic molecule containing a carbonyl group, the carbon of which is bonded to a hydroxyl group. Sedimentary rock forms from the remains of rock that has been weathered and eroded. Then the core of the star contracts again to produce even greater temperatures, and a new fusion series produces even heavier elements. How
was Hubble able to calculate the velocity with which these distant galaxies were receding? These colors together appear white. But in this second setting, chemical sediments form where temperatures are much cooler than Earth's interior, such as in a body of water on Earth's surface. (d) one quarter as strong. About how much impulse do you exert,
in comparison, if you catch the ball and immediately throw it back again? The most common isotope of carbon, C-12, for instance, has equal numbers of each—six protons and six neutrons. A friend says that is because Earth and the Moon are beyond the Sun's main gravitational influence. A B C D E 51. As the pressure is further reduced, more and
more of the faster-moving molecules boil away until the remaining liquid water reaches approximately 0°C. New acceleration = a = (1.2 m/s) = 1.0 m/s. The atomic nucleus is made up of two protons and two neutrons. So keep your eye to the nighttime sky for these meteor showers.
Have you noticed that things look darker when they are wet than when they are dry? In both cases the answer is 12.5 \text{ m/s}: Average speed = 100 \text{ meters} 50 meters total distance covered = 100 \text{ meters} 50 meters tot
obesity—or worse, cancer. (It is customary to omit the multiplication sign, *, when expressing relationships in mathematical form. (a) In accord with Newton's second law, the component of gravitational force that is parallel to the incline produces an acceleration parallel to the incline. Ecliptic The plane of Earth's orbit around the Sun. As an
exothermic reaction proceeds from reactants to products, the result is a release (dispersion) of thermal energy, which favors the formation of products. People were less aware of the effects of inertia. Since you exert in both cases is the same. Nonsilicate A mineral that
three dimensions of space plus one dimension of time. The remaining "pore water" often contains dissolved compounds, such as silica, calcium carbonate, and iron oxide. Scratching the itch spreads tetrahydrourushiol molecules over a greater surface area, causing the zone of irritation to grow. Similarly, many of the molecules that you have studied
in this chapter may have initially looked intimidating. 03 2019 v. Note that the area of greatest oscillation is always at the midpoint. Also, charged particles from outer space are deflected by Earth's magnetic field. Jupiter's moon Io has more volcanic activity than any other body in the solar system. During these moments, all regions of the universe
were still bound together. As the oceans evaporated, these carbonates transformed into carbon dioxide and moved into the atmosphere, increasing the intensity of the greenhouse effect. Interestingly, the North Star is in orbit around two companion stars, which means that the North Star is actually a triple star. The lowest-mass stars are brown
dwarfs, dim but longlived stars. CHECKPOINT Little tendency to lose or gain electrons True or false? Why don't photons that strike a pane of glass travel through it? Clastic rocks are classified by particle size (Table 20.3). Which travels slower in glass: red light? Fuse ribbon In modern buildings, fuses have been largely replaced by
circuit breakers, To circuit which use magnets or bimetallic strips to open a switch when the current is excessive. Two golfers each hit a ball at the same speed, but one at 60° with the horizontal and the other at 30° with the horizontal. Which of the following boxes contains only an element? Science is the product of human curiosity about how the
world works—an organized body of knowledge that describes order and causes within nature and an ongoing human activity dedicated to gathering and organizing knowledge about the world. CHAPTER 27 1. Why can't the elements of a compound be separated from one another by physical means? That energy tends to spread out is part of our
human experience. This is similar to the wrinkles you might find in a throw rug when you push one end of the rug toward the other end. This is like P-waves that compress and expand as they move through Earth's interior. Dark light appears where destructive interference occurs—where crests overlap troughs. Like charges repel; opposite charges
attract. Once you are comfortable, begin focusing on your out-breath. (It's important not to change subscripts, however, because to do so changes the compound's identity—H2O is water, but H2O2 is hydrogen peroxide!) For example, to balance the equation above, add a 3 before the NO: 3 NO(g) h N2O(g) + NO2(g) (balanced) Now there are three
nitrogen atoms and three oxygen atoms on each side of the arrow, and the law of mass conservation is not violated. 1 Atoms Are Ancient and Empt y 12. The buoyant force on a floating object is always equal to that object's weight, no matter what the fluid. This energy is then reradiated at longer wavelengths that cannot easily escape Earth's
atmosphere. Kohala Mauna Kea A Hilo Hualalai Kealakekua Bay Kapoho Mauna Loa Kilauea A´0 10 20 30 kilometers (a) Vesuvius A Sea level 0 Rainier Mt. Etna caldera FIGURE 20.21 The volcanic rock rhyolite comes in several forms. You can hear the sound of a distant train clearly by placing your ear against the rail. 3 9 A beam of light falls on an
atom and increases the vibrational motion of electrons in the atom. One kilogram of water would fill a 10-liter tank. 4 Alcohols, Phenols, and Ethers 19. Agents such as water, wind, ice, and reactive chemicals weather the rock—breaking it into smaller pieces, cracking its surface,
rounding and smoothing its edges and corners, and sometimes transforming its chemical composition. We don't know, and maybe never will. The pH is by definition the negative of this value, which 10 -1 1 Lemon juice means - ( - 7) = 7. It was the deadliest U.S. hurricane since the Okeechobee Hurricane of 1928. The essential physics concept in an
electric generator is (a) Coulomb's law. By analogy, consider the surface of planet Earth. An endothermic reaction, by contrast, requires that energy from the surroundings be absorbed by the reactants. A charged particle at rest does not interact with a static magnetic field. 4 Dark Matter 28. From a steamy mirror, wipe away just enough moisture to
allow you to see your full face. A nylon guitar string vibrates in a standing-wave pattern, as shown. What does the chemical bond or molecule that has no dipole. If light traveled at the same speed in raindrops as it does in air, would we have
rainbows? If it were not for air resistance, would it be dangerous to go outdoors on rainy days? Ernie Brown pushes a lawnmower and applies a force that pushes it forward and also against the ground. It was ship law that this task be done barefoot. (b) In homogeneous mixtures, the different ture, the different components can be seen as individual
substances, such as pulp components are mixed at a much in orange juice, sand in water, or oil globules dispersed in vinegar. As another example, the covalent compound carbon dioxide, CO2, consists of two double bonds connecting two oxygen atoms to a central carbon atom. To visualize what happens, imagine a group of people holding hands and
jumping around. Atomic masses for radioactive elements Not yet confirmed are the whole number nearest the most stable isotope of that element. 374 PA R T T W O CH E M I S T RY FIGURE 15.9 Ionic bonds formed Bonds for 
the Moon is 384,401 km. How does Earth's crust behave like a ship floating in water? Whether the ice cube is hollow or solid, it will displace as much water floating as it will when melted. The higher temperature causes the molecules of carbon dioxide gas to leave the liquid solvent at a higher rate. Resistance to current is usually greatest between
your feet and the ground, and so the current is usually not enough to do serious harm. Time-exposure photographs show that the Big Dipper appears to move in circles around the North Star (Figure 27.5). Science, Art, and Religion 10. After a month has passed, look for this same constellation at the same time of night. Solving for t, half the hang time
(one way), we get t = 2(1.25) m 2d = 0.50 s A 9.8 m/s2 A g Double this amount (because this is the time for one direction of an up-anddown round trip) and we see that such record-breaking hang time is 1 s. Heteroatoms have profound effects on the properties of an organic molecule. When steel naval ships are built, the location of the shipyard and
the orientation of the ship while in the shipyard are recorded on a brass plaque permanently fixed to the ship. This electric force of attraction between two oppositely charged ions is called an ionic bond. Extend Table 1.2 (which gives values from 0 to 5 s) to 6 to 10 s, assuming no air resistance. (d) becomes more conducting. Second, in a chemical C Horizontal C Ho
APTER14ELEMENTSOFCHEMISTRY355FIGURE14.11 The transformation of water to ice and the transformation of iron to rust both involve changes in physical appearance. If distant galaxies were all moving away from one another, that could only mean that they were once much closer together. (Use g = 9.8 m/s2.) 55. Gullible
investors put their money into some of these schemes. If there is a hole in the surface, the liquid spurts at right angles to the surface before curving downward because of gravity (Figure 5.7). So supermassive stars are born in smaller numbers to begin with. Such island arcs have formed the Aleutian Islands, the Marianas Islands, and the Tonga island
group in the South Pacific, as well as the island-arc systems of the Alaskan Peninsula, the Philippines, and Japan. Power g IV 39. Many of these atoms stay and become a part of my body. If the apple falls, what becomes of this energy just before the apple hits the ground? (A fission reaction may produce fewer or more than 3 neutrons.) These product
neutrons can cause the fissioning of 3 other uranium atoms, releasing 9 more neutrons. Show that the force of gravity is 4.0 * 10-8 N between a newborn baby (mass = 5.6 * 1010 m). That's the law! Action: tire pushes on road Action: rocket pushes on road Action: rocket pushes on road Action: tire pushes on road Action: rocket pushes pushes on road Action: rocket pushes pushes on road Action: rocket pushes push
gas Action: man pulls on spring Reaction: road pushes on tire Reaction: gas pushes on rocket Reaction: ball pulls on man Action: Earth pulls on ball Reaction: ball pulls on ball Reaction: ball pulls on Earth A B CHECKPOINT 1. These ideas culminated in the Declaration of Independence and the Constitution of the United States of America. When plotted, stars' positions take
the form of a main sequence for average stars, with exotic stars above or below the main sequence. One watt (W) of power is used when 1 J of work is done in 1 s. One coulomb (symbol C) is equal in magnitude to the total charge 6.25 * 1018 of electrons. It breaks apart into smaller rhombohedral shapes. Soap molecules are attracted to calcium and
magnesium ions because both have a 2 + charge. At least 1836 people were killed as a result of the hurricane and the floods that followed. A chemist who wants to carry out this reaction in the laboratory would be wasting chemicals and money if she were to combine, say, four carbon atoms for every one oxygen molecule. 92. CHAPTER 3 1. How
many more turns should be on the secondary compared with the primary? molecule, F Gaseous elemental fluorine A substance composed of atoms held together by covalent F I G U R E 1 5 .1 6 bonds is a covalent compound. An astronaut is provided a "gravity" when the ship's engines are activated to accelerate the ship. Plasma (not to be confused
with blood plasma) is the illuminating gas found in some TV screens and fluorescent and other vapor lamps. A sustained force of 50 N moves a model airplane 20 m along its runway to provide the required speed for takeoff. A similar process occurs with the scattering of light from atoms and particles that are far apart from one another. An
altocumulus cloud commonly appears to be the size of your thumbnail; a stratocumulus cloud appears to be about the size of your fist. Clearly visible are the hot gases exploding away from the central Sun-sized star, which is in the process of transforming into a white dwarf. The longer you wait, the larger the crystals will be. Outlet A mechanical
vacuum pump. When first formed, the elements were distributed evenly throughout because that is the way they accumulated. The European Alps were formed in a similar fashion when part of the African Plate collided with the Eurasian Plate some 40 million years ago. What happens, then, when you jump heavily on your feet from an elevated
position? Blowing gas into liquid polystyrene generates Styrofoam, which is widely used for coffee cups, packing material, and insulation. The sheet diminishes the amount of sound from the front side, producing a much fuller sound. Despite their fervent efforts and rituals, they never that interferes with sound from the sheet diminishes the amount of sound from the front side, producing a much fuller sound. Despite their fervent efforts and rituals, they never that interferes with sound from the sheet diminishes the amount of sound from the sheet diminishes the sheet dim
came close to succeeding. Because the heat travels quickly through the nail we say that it is a good conductor of heat. The face of each of these parallel planes is perpendicular to the main direction of the compressive force. If we compare the electric charges and masses of different atoms, we see that the atomic nucleus must be made up of more
than just protons. 78 PARTONEPHYSICS LEARNING OBJECTIVE Relate the concept of energy conservation to machines. Elements heavier than iron are created in stars. Chlorine does not remain in the atmosphere for very long. (a)
Impurities aren't necessarily bad; in fact, they may be good for you. The best knowledge filter ever invented is science. On a cold, rainy day, your car battery is dead, and you must push the car to move it and get it started. Water is removed when you overheat your toast, which is why burnt toast is black. For this reason, substances composed of polar
molecules typically have higher boiling points than substances composed of nonpolar molecules, as Table 15.2 shows. When an assistant whacks the anvil with a strong sledge-hammer blow, Hewitt is not injured. The electron-dot structure for an atom or ion is sometimes called a Lewis dot symbol, while the electron-dot structure of a molecule or poly-
atomic ion is sometimes called a Lewis structure. When the mass and particle are released, how does the KE (kinetic energy) acquired by each compare with the decrease in PE? What many people don't understand is that the brain works the same way: It too requires exercise in order to stay in shape. Watch for additional growth of HTS cables in
delivering electric power. Light waves do the same. It spun faster by the conservation of angular momentum. (b) C, A, B. In the center of the ridge and all along its length is a deep fissure—a volcanic rift zone. O O P O Phosphate ion 55. This is why mass is preferred to weight in scientific studies. If the initial universe remained hotter for a longer
period of time, would there likely be more or less helium? He also correctly estimates the speed of the waves. If the rubber band is part of a slingshot, it is capable of doing work. As a result, collisions between slow-moving N2 and O2 molecules, even those that collide in the proper orientation, may not form NO, as is shown in Figure 17.10. O xidation
is the process whereby a reactant loses one or more electrons. They would continue to work and not draw on their retirement plan until years later. After a succession of Rock-Forming Minerals EXPLAIN THIS M The density of a mineral
depends on a number of factors—the masses of the mineral's constituent atoms and the packing of these atoms, which, in turn, is a function of the atoms' sizes. (b) only the water freezes while the sugar remains in solution. We recycle waste products in new and better ways. In lab you submerge 100 g of 40°C nails in 200 g of 20°C water. These
hydrocarbons have the same molecular formula, C5H12, but they are structurally different from one another. Will your answer to the preceding question be different from one another. Will your answer to the preceding question be different from one another.
the volume of solvent because, in addition to containing the solvent, the solution also contains the solute. There are three types of tectonic plate boundaries: Plate (a) Plate 567 Plate Asthenosphere Plate (b) 1. Note that when R = mg, a = 0; then, with no acceleration, the object falls at constant velocity. Our planet is moving sideways along a path that
follows this curvature. The winds are steady, which benefited sailors of yesteryear—hence the name trade winds. The accuracy of weather in a wet (humid) climate? (Use g = 9.8 m/s2.) (b)
Show that the horizontal distance the airplane engine falls is 8.4 km. So, because of the Moon's eastward orbit, the Moon takes a bit longer than the Sun to travel from horizon. Devise a plan whereby a rocket loaded with radioactive wastes could be fired into the Sun for permanent disposal. According to cosmic inflation, the reason for
these fluctuations can be traced to the realm of quantum mechanics, which tells us that physical attributes such as position and momentum become fuzzy on the scale of the very, very small—such as the size of subatomic particles. Give two reasons heat is often added to chemical reactions performed in the laboratory. A rapidly spinning star shows a
redshift on the side turning away from us and a blueshift on the side turning toward us. The bubbles are bigger in the narrow part because internal pressure there is less. Voltage is induced in the magnetic field. The amount of energy required to pull two bonded atoms apart is the same as the amount released when they
are brought together. Try to float an egg in water. Solution: Using the equation Force = mass * acceleration we can calculate the force and the mass, and we want to find the acceleration. for analytical thinking. His eyes had been damaged earlier by
is the opposite of what occurs when air is compressed. Within a polyatomic ion, how many covalent bonds does a negatively charged oxygen form? Yet their luminosities are quite low—on the order of 0.1 LSun to 0.0001 LSun. As a result, for maximum range the ball must leave the bat with more horizontal speed than vertical speed—at about 25° to
however, is likely an unknown form of matter, called dark matter, that does not absorb or emit light. We can test whether something is in equilibrium by noting whether it undergoes changes in motion. It was once commonly obtained from whale oil, which is where it gets its name ("cetyl" is derived from cetacean). Organic molecules are classified
into four main parts: Physics, Chemistry, Earth Science, and Astronomy. The Sun would set in the east and rise in the west. Hewitt 76: Shutterstock 77: NASA/Goddard Space Flight Center 81: Paul G. When we say "normal to," we are saying "at right angles to," which is why this force is called a normal force. While inside the photon sphere, she could
that the presence of mass produces the curvature or warping of spacetime. FYI 5.0 5.26 8.9 10.5 19.3 a mineral's density is the ratio of its mass to its volume. Do you consider his hypothesis to be correct, incorrect, or partially correct? Quartz, composed of only oxygen and silicon, is a primary source of silicon for making microchips. Discuss your
explanation of this with your friends. Oxygen isn't just important as a constituent of air—in the solid state, it makes up most of Earth's crust. Is sugar a polar or nonpolar substance? (d) none of these 7 C H A P T E R 7 Heat Transfer and Change of Phase W hy doesn't coauthor John 7. In each breath we inhale, we recycle atoms that once were a part of
water— H HO OH H O eventually, a point is reached at which there are not enough CH2OH HO water molecules to separate the sucrose molecules from one H OH another. Rather than moving the magnet, it is more practical to move the coil. Weight The force due to gravity on an object. (c) at right angles to the line between the Moon and
Earth. (1 N = 1 kg # m/s2) Work g force: distance; W g Fd 41. But on an incline, the force of gravity has a vector component parallel to the alley, as sketch B shows. As you learned in earlier chapters, these particles combine to make the atoms of the periodic table. The polymer styrene-butadiene rubber (SBR), shown here, is used for making tires as
well as bubble gum. Ohm's law The current in a circuit varies in direct proportion to the potential difference of 1 V across a resistance of 1 V. Should we do so mindlessly or mindfully? As we see in Figure 19.14, ethanol and
dimethyl ether have the same chemical formula, C2H6O, but their physical properties are vastly different. Seen from an airplane near midday, the bow forms a complete circle. Park; Oxford University Press, 2000. Hewitt 397: (bottom) John Suchocki/ Paul G. As discussed in the previous section, the greater the polarity of the molecule, the greater
LEARNING OBJECTIVE Recognize the important role that molecular interactions play in determining the physical properties of a material. Apply a small magnet to the door. Liquid water Water vapor When you remain in the moist shower stall, the rate of condensation is higher and you feel warmer. The person's eye at point P looks into the mirror.
19.6 Carbonyl Compounds EXPLAIN THIS Why does the carbon of the carbonyl usually have a slightly positive charge? Although this fresh water is more costly than fresh water from natural sources, one could argue that the higher cost reflects fresh water is more costly than fresh water is more costly than fresh water is more costly than fresh water from natural sources, one could argue that the higher cost reflects fresh water is more costly than fresh water from natural sources, one could argue that the higher cost reflects fresh water is more costly than fresh water is
the first three elements of group 18. (b) Would acceleration be greater or less if the ramp were a bit less steep? In set B, new molecules, consisting of bonded red and blue spheres, appear after the change. Easyto-draw stick structures that use lines for all carbon-carbon covalent bonds are also useful. E lectrolysis is the use of electric energy to
produce chemical change. Wegener died while crossing an ice sheet on an expedition of Greenland. 3 F I L L I N G T H E S Q UA R E S O N T H E C H E S S B OA R D harvested in the entire history of the Earth! Square Grains Total Grains It is interesting and important to note that the number or Number on Square Thus Far grains on any square is
one grain more than the total of all 1 1 1 grains on the preceding squares. Step 5: Turn off the heat. A person on a diet loses mass. Of these carbon atoms, about 65 billion (6.5 * 1010) are the radioactive C-14 isotope. So the core was found to have two parts—a liquid outer core of molten iron and a solidiron inner core.
AA Subduction zone n Sa San Francisco Relative motion of North American Plate r And eas Fault Los Relative motion Angeles of Pacific Plate (a) FIGURE 21.29 (b) (a) The San Andreas Fault is a transform plate boundary famous for its earthquakes. q1q2 41. If a proton were added to each germanium nucleus, however, you would not want to
swallow the capsule because the germanium would (a) become arsenic. The main reason it gets hotter down below is that Earth contains an abundance of radioactive isotopes and is heated as it absorbs radiation from these isotopes. Each type of metamorphism is characterized by differences in mechanical deformation and recrystallization. The
universe you left behind has run through infinite time and exists no longer. Because of its tangential velocity, it falls around Earth rather than vertically into it. As the soda water loses carbon dioxide molecules, it is losing the carbonic acid that these carbon dioxide molecules form when in solution. Write the balanced chemical equation. † The speed of
sound in a gas is about 34 the average speed of its molecules. 3 O2(g) h 2 O3(g) Was this your answer? The ratio of weight to mass for freely falling objects equals the constant g. C; when close to the Sun, the Moon is necessarily in a crescent phase. Water flows in a pipe that connects the reservoirs only as long as a difference in water level exists. As
Hubble studied these distant stars he discovered that some of them were of a certain type, called Cepheids, that regularly change how bright they are over a period of a few days. An- Metal ions are held together by freely flowing electrons. Polar water molecules, however, are also able to induce dipoles within the nonpolar tails of the soap molecules.
The distance traveled is 20 kilometers and the displacement is zero. What is the result? The pressure outside—on top of the fabric, where air is moving—is less than the static atmospheric pressure on the inside. They are produced in the air in an organ pipe, a flute, or a clarinet—and in the air of a soft-drink bottle when air is blown over the top. (b) v
= 60 km/h + 40 km/h = 100 km/h. 34. Like a more tightly stretched guitar string, the rope with greater tension twangs at a higher pitch. How many meters below the dashed line would it be at the end of the 5 s? This energy release by condensation is used in steam-heating systems. Yet because the Martian atmosphere is relatively thin, it doesn't trapped to the string the rope with greater tension twangs at a higher pitch. How many meters below the dashed line would it be at the end of the 5 s? This energy release by condensation is used in steam-heating systems.
its inertia. Spectroscope A device that uses a prism or diffraction grating to separate light into its color components. A common sulfonate, or LAS, often found in dishwashing liquids. As the two galaxies merge, the interstellar gases and dust mix. Why are low-formula
mass alcohols soluble in water? Light doesn't O D D - N U M B E R E D S O LU T I O N S get through two crossed Polaroid filters—say, 1 and 2—because their axes are at 90° to each other. Inertia isn't a kind of force; it's a property of all matter to resist changes in motion. For convenience, values such as these are often rounded off to the nearest
whole number. (a) From Fd = ©KE = 1 2 mv2 2 mv © 12 mv2; d = = . LEARNING OBJECTIVE Recount how the quantum nature of energy led to Bohr's planetary model of the atom. The figure neglects the effects of air resistance, so the trajectories are all parabolas. Many more stars become visible with a telescope, especially when the telescope is
pointed toward a cloudlike band of light that stretches north to south. 566 PA R T T H R E E E A R T H R E E E
some truth to it. To separate them requires an input of "muscle energy." Conversely, when the two separated magnets collide, they become slightly warmer than they were, and this warmth is evidence of energy released. The asteroid belt is between the orbits of Mars and Jupiter. Frost forms directly from water vapor as a result of deposition. But
against the bright sky what you see is predominantly the sky minus the light scattered by the smoke. Atoms of the noble-gas elements tend not to form ions of any type because their valence shells are already filled to capacity. (With air friction, it would be less.) 109 a b c d FIGURE 4.35 INTERACTIVE FIGURE If Superman tosses a ball 8 km/s
horizontally from the top of a mountain high enough to be just above air resistance (a), then about 90 min later he can turn around and catch it (neglecting Earth's rotation). They travel in the same direction. From hardest to softest, rank the following minerals: (a) quartz, (b) halite, (c) diamond, (d) gold. The force acting on your hand is the same
Plutonic rocks (such as granite) form below Earth's surface where they cool slowly; they tend to have much larger crystals that are easily seen without magnification. When you pull the cart simultaneously pulls on you. On a keyboard, you strike middle C, whose frequency is 256.0 Hz. (a) Show that the period of one vibration of this tone is
0.004 s. (If the cardboard is thick, make it through a piece of aluminum foil placed over an opening in the cardboard.) Aim the camera at a bright object in a darkened room, and you see an upsidedown image on the tissue paper. If, by returning to the original set of conditions, you return to the original physical appearance, then the change was
physical. Although benzene may cause cancer, aspirin works as a safe remedy for headaches. (a) By how much does the speed of the wavelength per second passes the pole, then the speed of the wave is 1 m/s. So you're shorter at the end of the day. More than 150,000 physical.
asteroids have been cataloged so far, but many more no doubt have yet to be discovered. Thus the units of molar mass are grams per mole. In Teutonic, the Sun is Sun (Sunday), Venus is Fria (Friday), and Saturn is Saturn (Saturday). And
as rock at Earth's surface is touched by water and air, it begins to erode and weather and is broken up into smaller rocks. Consider an imaginary miracle car that has a 100% efficient internal combustion engine and burns fuel that has an energy content of 40 megajoules per liter (MJ/L). In order to understand reverse osmosis, you must first
understand osmosis. All uranium ultimately becomes lead. The angle of incidence is equal to the angle of reflection. LEARNING OBJECTIVE Distinguish between models that describe physical attributes and models that describe the behavior of a system. For nitroglycerin and similar high explosives, these gases expand at supersonic speeds, creating and similar high explosives.
powerful and destructive shock wave. Also, in natural processes, high-quality energy—order tends to disorder. The types of clouds that form depend on the air's stability and moisture content. From this time to about 10100 years in the future, supermassive black holes will likely be the dominant form of
mass in the universe. In a sporting goods store you see what appears to be two identical life preservers of the same size. (Tell your friends that every atom in their bodies contains a nucleus!) CHECKPOINT What is the major similarity between a galvanometer and a simple electric motor? Eclipses occur only when the plane of the Moon's orbit
intersects the plane of Earth's orbit about the Sun, which seldom happens. Any objects in the solar system without sufficient tangential velocities have long ago crashed into the Sun. These fluids can also initiate magma generation far away from the site of metamorphism as they migrate upward and drive fluid-induced melting. Compared to an empty
ship, would a ship loaded with a cargo of Styrofoam sink deeper into water or rise in water? Velocity acquired and distance fallen* are shown in Table 1.2. Velocity = 0 3s t=0s 2s 4s v = -10 m/s 5s v = -20 m/s 5s v = -20 m/s 6s v = -30 m/s 6s v = -40 m/s 1s v 
a falling boulder is equipped with a speedometer. Asteroids have been moving through space for billions of years. The total positive charge balances the "electrical pressure" to move electrons through a circuit joined to those terminals
When is energy most evident? This release of heat involves the spreading out of energy, which is, by definition, an increase in entropy. (c) Helium, aluminum, argon. TUTORIAL: The Sun 26.2 The Sun EXPLAIN THIS T Why is the Sun's surface much cooler than its inner core? 477 FIGURE 18.28 Because this bus is powered by a fuel cell, its tailpipe
emits mostly water vapor. F L U I D M E CH A N I CS 123 LEARNING OBJECTIVE Relate the buoyant force to pressure differences in a fluid. You tell your friend that the acceleration of a skydiver decreases as falling progresses. One's lungs, like an inflated balloon, are compressed when submerged in water, and the air within them is compressed.
Gas-filled balloons that rise in air are less dense than air. The chemistry chapters begin with a look at the submicroscopic world of the atom, which is described in terms of subatomic particles and the periodic table. When it is moving horizontally, it is boosted to the required speed for orbit. Hewitt 401: Shutterstock 402: (a) Corbis RF/AGE Fotostock
402: (b) iStockphoto 402: (c) Shutterstock 407: (top) Fotolia 407: (bottom) John Suchocki/ Paul G. The mountains of the Himalayas are slightly less dense than they are high? The near-empty bottle of seltzer water thus becomes quickly
influences (Figure 28.9). Explain what happens. But, regardless of how the cue ball is struck, in the absence of external forces, both linear and rotational momentum are always conserved. The waterwheels used in gold-mining operations were not very effective. CHECKPOINT If the Sun somehow suddenly collapsed to a black hole, what change would not be a conserved.
occur in the orbital speed of Earth? The Oort Cloud and Comets As the jovian planets grew, their gravitational interplanetary debris. loaded, it is denser and floats lower in the water—more of it is submerged than when it is empty. This behavior is summarized in
Figure 18.10. A car's headlight dissipates 40 W on high beam. Other addition polymers are created by using different monomers. Galaxy A large assemblage of stars, interstellar gas, and dust, usually catagorized by its shape: elliptical, spiral, or irregular. Acceleration is defined as the time rate of change of velocity and is
produced by a force. Such a change is produced when the iron parts of a car pass over it, momentarily increasing the strength of the field. Power plant First hole MOMENTUM AN D ENERGY Water circulation Dry-rock geothermal power. Scientists of Wegener's day rejected continental drift because they couldn't imagine how massive, rocky
continents could grind through the solid rock of the ocean floor. Why might a high-formula-mass alcohol be insoluble in water? Water migrating upward from the descending plate lowers the melting point of the mantle rock above the sinking slab, causing partial melting. Electromagnetic spectrum The range of electromagnetic waves that extends in
frequency from radio waves to gamma rays. 490 PARTTWOCHEMISTRY LEARNING OBJECTIVE Identify the structures of hydrocarbons. What has been a practical application of this? s we have discussed in the preceding two sections, reactants must have a certain amount of energy in order to overcome the activation energy so that a
chemical reaction can proceed. The hydraulic press does not violate energy conservation, because a decrease in the distance moved compensates for the increase in force. 27.6 Galaxies All the celestial objects discussed so far in this and the preceding chapter are located in what galaxy? M. Phosphoric acid, as shown in Figure 19.18, reacts with
caffeine to form the caffeine-phosphoric acid salt, which is much more soluble in cold water than the naturally occurring tannin salt. The natural frequency of water molecules coincides with the frequency of infrared light, so infrared light
sediment load. Golf balls, for example, are about 20 times as massive as Ping-Pong balls, which is to say the relative mass of golf balls to Ping-Pong balls is 20 to 1. Its axis is tilted 98° to the perpendicular of its orbital plane, so it lies on its side (Figure 26.20). They don't because of sufficient tangential velocities. It is difficult to estimate the amount of
energy consumed in shipping this bottled water from its source to the customer, but because water is so dense, the amount is likely huge. Primary waves, like sound waves, are longitudinal—they compress and expand the rock as they move through it. The customer is being reasonable. Three different types of molecules are shown: one with two small
blue circles joined, one with a larger red circle joined, and one with two larger red circle joined. For example, when a teaspoon of table sugar is mixed with 1 L of water, we identify the sugar as the solute and the water as the solvent. Would you expect this material to be very soluble or not very soluble in water? Mothballs are
well known for their sublimation. 7.7 Boiling LEARNING OBJECTIVE Explain the cooling nature of the boiling process. (b) interference. Nonetheless, consumers are still willing to purchase bottled water at up to $2 per liter! Each year, Americans spend about $400 million on bottled water, and the market continues to grow rapidly. As shown in Figure
14.4, for example, two hydrogen atoms and one oxygen atom link together to form a single molecule of water, which you know as H2O. For example, if we are submerged in water pressure. How does the Doppler effect aid police in detecting speeding
and the star contracts, which boosts its temperature. As Figure 5.16 illustrates, each water-filled caisson weighs the same whether or not it carries boats (or multiple boats or even no boats as long as the water in each caisson has the same whether or not it carries boats (or multiple boats or even no boats as long as the water in each caisson has the same depth).
light signal is "thought about" before it goes to the optic nerve and then to the main body of your brain. If the piston is pushed downward so that the volume is half the original volume, the density of molecules is doubled, and the pressure is correspondingly doubled. Which type of rock is most sought by petroleum prospectors: igneous, sedimentary
or metamorphic? In fact, the time of glaciation in the Southern Hemisphere was a time of subtropical climate in the Northern Hemisphere. The opposite "counterjet" receding away from us at such great speeds is barely visible. By the inverse-square law, particles twice as far apart have 1/4 the force; particles three times as far apart have 1/9 the
force. Some older cars vibrate loudly when moving at particular speeds. Draw two parallel lines from the equator pointing exactly north-south. So unstable air rises, but stable air rises, but stable air does not. Will the pH also drop when carbon dioxide is bubbled into a solution of 1 M hydrochloric acid, HCl? Ice is less dense than water, and hence ice floats in water.
Hewitt Nuridsany et Perennou/ Photo Researchers, Inc Paul G. People who live in areas with frequent earthquakes are generally better prepared than those in areas where earthquakes are rare. Mineral A, because high-silica minerals are the first to melt. CHAPTER 4 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L I T E S Putting a payload into
For example, intensity 1 is barely felt, intensity 1 is barely felt, intensity 5 is broken chimneys, and, intensity 12 is total damage. The second law speaks of the quality of energy becomes more diffuse and ultimately degenerates into waste. The spring of 2011 was an exceptionally destructive and deadly tornado season. An auto starting from rest has a constant
acceleration of 4 m/s2. In what direction are the vibrations in a transverse wave, relative to the direction of wave travel? Sodium atoms emit bright yellow light. Nonetheless, for a special assignment, you might try your analytical-thinking
skills on the following problems. EXPLAIN THIS I f a material is pure, it consists of only a single element or a single compound. F I G U R E 1 4 .1 2 COOL HOT COOL Potassium chromate changes color as its temperature changes. It is possible that your instantaneous speed at some point was (a) less than 5 m/s. Distance of fall = 2 gt = 2 (10 m/s) (3 s)
= 45 m. Atoms are so small, however, that a single grain of sand contains on the order of 125 million trillion of them. See Chemical reactions net actions Recrystallization, 545 Reduction, 470. The vigorous collisions help disrupt 40 electrical particle-to-particle attractions in the solid. When liquid acetic acid is added to water, only a few acetic acid molecules
react with water to form ions. Carbon, for example, has an atomic mass of 12.011, which is slightly greater than 12.000 because of the few heavier carbon. They are also the sites of lithospheric formation and destruction. By comparison, one type of active galaxy, known as a starburst galaxy, can
produce more than 100 new F I G U R E 2 7. Why can a hum usually be heard when a transformer is operating? Objects don't speed up, slow down, or change direction unless a force acts. The orange still accelerates. The leftmost diagram below shows the moving particles of a gas within a rigid container. This keeps amateur astronomers busy looking
night after night, for the discoverer of a comet gets the honor of having it named for him or her. From the definition that work = force * distance, simple rearrangement gives distance = work/force. When it is connected to a 120-V household circuit, a transformer is needed. y 3.0 m d (a) Show that the ball takes 0.5 s to hit the floor. It's true that light
has no mass, but it is not "energyless." The fact that gravity pulls downward on light provides evidence that gravity pulls on the energy of light. Seafloor spreading initiates the movement of the concentration of H3O+ goes up, the concentration of OH- must go down, and the product of the two remains 1.0 * 10-14. Note that, at
successive positions one-fourth, onehalf, three-fourths, and all the way down, the total energy is constant. CHECKPOINT Is it possible for one type of galaxy to turn into another? Which forms the negative ions? The plastic then has an excess of electrons and is negatively charged. Compounds have physical and chemical properties that are different
from the properties of their elemental components. The designs for nuclear power plants have progressed over the years. 2 H2S + 3 O2 h 2 H2O + 2 SO2 OH 71. (b) In wave terminology, speed = frequency * wavelength = (15 Hz)(15 m) = 3 m/s. The heated air does work as the sides of the can expand, exerting a force for some distance on the
                           here. An observer on the back side of the Moon would never see Earth. The inner planets of our solar system, for example, orbit the Sun and experience greater gravitational forces. This natural acidity of rainwater may accelerate the erosion of land, and under
certain circumstances it can lead to the formation of underground caves. Blimps, airplanes, and rockets operate under three very different principles. Does the fact that air naturally spreads out mean that entropy increases or decreases? Today this technology is growing rapidly. Because the oceanic crust is thinner, it doesn't extend as deep into the
mantle. Can you see that the temperature of the enclosed air is lower when it does work than when it does work that when it does work tha
A S E 173 F I G U R E 7. A student that you're tutoring says that the two terms wave speed and wave frequency refer to the same thing. CHECKPOINT A skydiver jumps from a high-flying helicopter. This is the process of cementation. The result is that students learn more and improve their test scores. A sonic boom cannot be produced by (a) an
aircraft flying slower than the speed of sound. He found fossils of identical land-dwelling animals in South America and Africa but nowhere else. A student friend says that the vacuum sucks in the sides of the drum. Oxygen can pluck electrons from many other elements, especially those that lie at the lower left of the periodic table. Science Has
Limitations 8. Why doesn't water boil at 100°C when it is under higherthan-normal atmospheric pressure? But if the rocket engines can be sustained for long periods of time, the maximum amount of carbon dioxide, CO2,
that can be formed? 82. Pennies made after 1982 contain both copper and zinc. Closely observe the physical world around you. By what mechanism does a compass needle align with a magnetic field? CHAPTER 9 1. The inner rings move faster, like the greater speed of inner planets or any close-orbiting satellites. Opposite forces on the ends of the
fibers (or compass needle) produce torques that orient the fibers along the field direction (look ahead to Figure 9.4 in Chapter 9). Once it passes beyond this mathematical boundary, however, there is no possible return. The Sun will shrink, but only up to the point at which electrons resist trespassing into the quantum states of their neighboring
electrons. The structure for hexanol is therefore the most nonpolar of these three molecules; hence, it has the lowest solubility in water. Project what human civilization would be like if Earth had no Moon. In the end, you have given away no bottle caps. Do the illustrations represent a physical model or a conceptual model? Wheels from a toy cart are
rolled from a concrete sidewalk onto the following surfaces: (a) a paved driveway, (b) a grass lawn, and (c) close-cropped grass on a golfcourse putting green. EXPLAIN THIS LEARNING OBJECTIVE Relate the conditions under which momentum is and is not conserved. How does the V shape of a bow wave depend on the speed of the wave source?
Jupiter A Moon 57. If a 1-L container is immersed halfway in water, what is the volume of the water displaced? F = G 2 = 6.67 * 10 - 11 N # m2 > kg2 * d (0.5 m)2 = 8.0 * 10 - 8 N. (c) Love surface waves whip back and forth like secondary body waves, but only in the horizontal direction. There is no net force for us to sense. What is the buoyant force
that acts on this ship? Meteor The streak of light produced by a meteoroid, that has survived passage through Earth's atmosphere to reach the ground. What exactly does the pushing? Such a solution is said to be acidic. The word metamorphic means
"changed in form." For example, marble is metamorphosed limestone, and slate is metamorphosed shale. Jupiter jupiter is the largest of all the planets. This is because the table is forced to vibrate, and its larger surface sets more air in motion. Boyle's law The product of pressure and volume is a constant for a given mass of confined gas regardless of
changes in either pressure or volume individually, so long as the temperature remains unchanged: P1V2 = P2V2. There are many instances in which the dipoles of different bonds in a molecule do not cancel each other. Should the mold also be 6 inches tall? A specific chemical composition means that, for two samples to be considered the same
mineral, they must have the same basic chemical composition. Most chemists choose applied research as their major focus. Dry skin has considerably more electrical resistance than wet skin. In which parts of Earth's crust (oceanic and/or continental crust) do we find the two common igneous rocks, basalt and granite? Dipole—induced dipole
attraction OOH OOOH Isolated oxygen molecule (nonpolar) (a) Induced dipole (oxygen molecule (a) An isolated oxygen molecule (nonpolar) (b) Permanent dipole (water molecule) FIGURE 15.35 INTERACTIVE FIGURE (a) An isolated oxygen molecule (nonpolar) (a) Induced dipole (oxygen molecule) (b) Permanent dipole (water molecule) FIGURE 15.35 INTERACTIVE FIGURE (a) An isolated oxygen molecule) (b) Permanent dipole (oxygen molecule) (c) Permanent dipole (oxygen molecule) (d) Permanent dipole
ignition of thermonuclear fusion within the core of a large mass of gasses compressed by gravity. The same amount of work is done when carrying a bag of groceries up a flight of stairs, whether we walk up or run up. 8, 2014 Sep. In contrast, a definite limit exists at the lower end of the temperature scale. Even a small charge produces an electrical
force greater than the weight of strands of hair. You can reverse this reaction by allowing the silver to get its electrons back from aluminum. Within six years the first test nuclear bomb was exploded in the desert in New Mexico. When a light ray passes at an angle from water into the air, the ray in the air bends (a) toward the normal. The first is the
Kuiper belt, which lies roughly within the same plane of the solar system. Consider the hypothesis "The alignment of planets in the sky determines the best time for making decisions." Many people believe it, but this hypothesis is not scientific. Pigments are tiny particles that absorb specific colors. In such a spaceship at rest or in uniform motion
relative to the distant stars, he and everything within the ship would be no "up" and no "down." But if rocket thrusters were activated to accelerate the ship, things would be different; phenomena similar to gravity would be observed. Attractive forces then pull the atoms into orderly crystalline structures. Recrystallization
occurs when the minerals in a rock change because the rock was subjected to higher temperatures and pressures than the conditions under which is hotter than magma, why are the 0 rocks at depth solid? Similarly, O2 is the
elemental formula for the oxygen we breathe, and S8 is the elemental formula for sulfur. 712 PA R T F O U R ASTRONOMY The formation of the spinning disk explains the motions of our solar system today. A by-product of nuclear power in Earth's interior is geothermal energy. Unfortunately, tertiary treatment is costly and is normally used only
when the need is vital. Hewitt 261: Paul G. The greater mass reflects the energy required to pull the nucleons apart from one another. Oxygen, O2, is certainly good for you. Give two reasons why pouring a cup of hot coffee into a saucer results in faster cooling. The result is that pieces of the nucleus fragment away in the form of radiation, as
indicated in Figure 13.14b. Because H2SO4 is a strong acid, it readily forms hydronium ions when dissolved in water is slightly denser at 64 lb/ft3. Just as narrow pipes resist water flow more than wide pipes, thin wires resist electric current more than thicker wires. One mole of carbon dioxide (formula mass 44 amu) is 44 g. You don't get
something for nothing. The ionic bond is merely the electrical force of attraction that holds ions of opposite charge by electromagnetic induction, a process we will describe in the next chapter. When you listen to a radio, why do you hear only one station at a time instead
of all stations at once? 22 Dec. The shell of the kernel, however, is airtight and this keeps the water as a superheated liquid. (d) the differentiation of life forms. Hang time is related to the vertical height attained in a jump, not to the horizontal distance moved across a level floor. The 19th-century author and social commentator Thomas Carlyle wrote,
"Why did not somebody teach me the constellations and make me at home in the starry heavens, which are always overhead and which I don't half know to this day?" What is the principal difference between a radio wave and light? We interact with our environment, like
bumping our head against a cabinet, because of the repulsive electric fields that prevent atoms from overlapping one another. As a result, very little or none of the light remains to come back out of the opening and travel to your eyes (Figure 7.17). n air mass is a volume of air much larger than the parcels of air we've discussed so far. Water is 88.88%
oxygen by mass. A transformer changes voltage and current, but not energy and power. The temperature after shaking is transformed into thermal energy of shaking is transformed into thermal energy and power. The temperature after shaking is transformed into thermal energy. The limit is exceeded at more than 1-m deep. How
does the Moon's rate of rotation about its own axis compare with its rate of revolution around Earth? If, for example, a pair of like charges of 1 C each were 1 m apart, the force of repulsion between the two would be 9 billion N.* That would be about 10 times the weight of a battleship! Obviously, such quantities of net (b) charge do not usually exist in
our everyday environment. Marble is metamorphosed limestone that succumbs more easily to chemical weathering. Thus the sky is brighter inside the rainbow than outside it. What is the IUPAC systematic name for the compound KF? The next planet, Mars, which is only a bit larger than Mercury, would be an apple seed almost two football field
lengths away from our solar beach ball. According to cosmic inflation theory, how long did it take for the universe to increase its size by a factor of 1030? Does this hold true if the hot rock is dropped into the Atlantic Ocean? The photons of light are climbing against the gravitational field and losing energy. A common misconception is that sonic
booms are produced when an aircraft breaks through the sound barrier—that is, just when the aircraft exceeds the speed of sound. (d) scattering. What value is there in having these sorts of deeper understandings? They are simple questions and all answers are easily discovered in the chapter. A common thermometer measures temperature by
means of the expansion and contraction of a liquid, usually mercury or colored alcohol. Which produces more radioactivity in the atmosphere: coal-fired power plants or nuclear power plants or nuclea
0.75c when it refracts through a particular piece of plastic. So we see that Earth and the Moon simultaneously pull on each other, each with the same amount of force. Airbags lengthen the time of impact. Whether the magnetic field moves near a stationary conductor or vice versa, voltage is induced either way
(Figure 9.23). (b) Lakes and rivers lined with inert materials are not protected. Because impulses are greater when an object bounces. In other words, they are more "sticky." Iodine, I2, for example, is stickier than fluorine, F2, which explains why iodine is a solid at room temperature while fluorine is a gas, even though they are both nonpolar
materials. They conduct electricity and heat, are opaque to light, and deform—rather than fracture—under pressure. Asthenosphere, a zone of plastic, easily deformed rock. They are, however, giants in the submicroscopic world—if a typical polymer molecule were as thick as a kite
string, it would be 1 km long. The paint is then spread over an area four times as big, and its thickness would be only 14 mm. Fluorescent lights contain spectral lines from the light emission of mercury atoms. The spray at the crest of the wave appears white because, like clouds, it is composed of a variety of tiny water droplets that scatter all the
visible frequencies. So just as an X-ray or CAT scan reveals the interior of your body, a seismogram reveals Earth's interior. CHECKPOINT Evan, shown to the right, has grown an inch in height over the past year. Because the negative charge of the ion is so nicely accommodated, the phenolic group is more acidic than it would be otherwise. With both
eves open, look past your finger at a distant object. Polypropylene consists of a polyethylene backbone with methyl groups attached to every other carbon atom. Hence we see instances where scarcity is created to keep the economic system functioning. Distinguish between electric potential energy and electric potential in terms of units of
measurement. Why does increasing the temperature of a solid make it melt? Exactly 1 s later its speed will be (a) the same. But what is a vacuum? The temperature of the liquid would not change monoxide only with the application of much heat, as occurs adjacent to a lightning bolt or in an internal-
combustion engine. When a ball is hit with a given force, why does contact over a long time impart more speed to the ball? Where does most magma originate? 20.9 Metamorphic Rocks 28. Hence, a surface that reflects very little or no radiant energy looks dark. A car accelerates along a road. Many windows are blown outward in strong winds.
However, the ability to produce aspirin from petroleum depended on an understanding of atoms and molecules developed from many years of basic research. At 50°F the maximum amount of water vapor in air is 9 g/m3. It therefore has less KE. The acetic acid solution has more hydronium ions, but not as many as the hydrogen chloride solution. Her
research showed that P140° waves refract not only at the core- No direct mantle boundary, but also at a P-waves S-waves certain depth within the core, where they gain speed. At sunset, more reds would be scattered by the longer distance traveled by the sunlight, and the sunlight would be predominantly blue and violet. The lower mantle is
essentially a single unit from a depth of 2900 km up to about 700 km. and What might be its ultimate fate? Beta particles readily pass through paper, but not through a sheet of aluminum. If you bring a bag of potato chips aboard an airplane, you'll note that the unopened bag puffs up as the plane ascends to high altitude. Newton's calculations didn't
check. Check the Internet for information about Betelgeuse. Yes; the principle of lateral continuously deposited over large areas until some sort of obstruction, or barrier, limits their deposition. Show that 100 q of 100°C steam will completely melt 800 q of 0°C ice. Does electric charge flow across a circuit
or through a circuit? The twice-asmassive cart undergoes only half the acceleration of the less massive cart and gains only half the speed. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Acid A substance that donates hydrogen ions. (b) This is what the eye sees when the slit of a
diffraction-grating spectroscope is pointed toward a whitelight source. So we can't assume the buoyant force is greater on floating things! 119. Smoothness is relative to the wavelength of the illuminating waves. The concern of science is the physical universe; the concern of religion is spiritual matters, such as belief and faith. At this point, the
protons and neutrons would have begun fusing into deuterium nuclei (consisting of one proton and one neutron). Solution: = -(-9) = 9 = -log 10-3 Solution: SAM PLE PROBLEM 4 = -log 10-9 pH = -log 10-9 p
momentum of any system is conserved if no net forces are Jonust acting on the system, angular momentum is conserved if no net torque acts the system. 25.4 Air Masses, Fronts, and Storms 23. Earth's surface also curves 5 m beneath a straight-line 8-km tangent. So the coil must repel the magnet.) We have mentioned two ways in which voltage can
be induced in a loop of wire: by moving the loop near a magnet and by moving a magnet near the loop. Starting in the 1960s, astronomers began discovering extremely energetic bodies hundreds of times more luminous than our own galaxy, yet farther away than any observed object. If a parcel of dry air initially at 0°C expands adiabatically while
flowing upward alongside a mountain, what is its temperature when it has risen 2 km? Do you also see that only 1.5 moles of oxygen gas would be produced from the reaction of 1 mole of KClO3 solid? The particles can then slip past one another and tumble around much like a bunch of marbles in a bag. Rank in order of decreasing pH the rain that fell
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on the Hawaiian island of Kauai on the mornings of (a) January 18, 1778; (b) December 7, 1941; (c) May 8, 2010. The driving force is needed to start an object moving, no force is needed to keep it moving—except for the force needed to start an object moving.
to overcome friction (more about friction in Section 1.8). It has two compartments, one for entering hydrogen fuel and the other for entering oxygen fuel, separated by a set of porous electrodes. Gold, because of its large atomic size, is soft (hardness = 10). The same
pizza placed in a hotter oven is a net absorber. (c) The answers are the same, but for different speeds. Or metamorphic or sedimentary rocks at Earth's surface may decompose to form sedimentary rocks at Earth's surfac
scientists have discovered that gases are made of molecules, but that's not good enough for him. Where does the net energy released in an exothermic reaction go? Pure marble is white and is virtually 100% calcite, which is neither platy nor elongated. 306 PA R T T W O CH E M I S T RY Although we cannot see atoms directly, we can generate
images of them indirectly. (a) What is the velocity of the ball when it reaches its highest point? The mosquito should fly toward you into the breeze. The final result is that the hydronium-ion concentration is lower than the hydroxide-ion concentration. We see that component f is along the orbital path but against the direction of motion of the satellite
Thermosphere The fourth atmospheric layer above Earth's surface, extending from the top of the mesosphere to 500 km. HOT How are compounds different from elements? Why does buoyant force act upward on an object submerged in water? Which box below contains only an element? As the car battery is recharged, the PbSO4 is transformed back
into lead, Pb. Rechargeable lithium-ion batteries have found a wide range of applications, such as powering laptop computers and cell phones. A satellite at a particular point along an elliptical orbit has a gravitational potential energy of 5000 MJ with respect to Earth's surface and a kinetic energy of 4500 MJ. Newton's second law states that if no net
force is exerted on a system, no acceleration occurs. Identify the following functional groups in this organic molecule: amide, ester, ketone, ether, alcohol, aldehyde, amine. The atoms present at the beginning of a reaction merely rearrange to
form new molecules. Punch a couple of holes in the bottom of a water-filled container, and water spurts out because of water pressure. P-waves travel through both, a heavy weight attached to a string and used by carpenters and surveyors to establish a straight
vertical line, gets it name from the lead (plumbum, Pb) that is still sometimes used as the weight. Nonetheless, those who live in Alaska see a crescent Moon that is much more upright than those who live in Hawaii. On a clean and polished aluminum or silver surface, however, about 90% of the incident light is reflected. L St or m tr a c k (e) Occluded
front developed (f) Cyclone dissipates Cold Co ld Co Cold Low ld Warm Warm Low Co ld W
the speed of the satellite exceeds 8 km/s, (a) it overshoots a circular path and travels away from Earth against the channel. This is best understood classically; nothing in Newton's law of gravitation, F = G mM, changes.
This is because a rocket must move against the greater gravitational field of Earth most of the way. Why are catalysts so important to our economy? A satellite must not contend with either of these. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 98. Morphine and caffeine are two alkaloids. A ball is released from rest at the left of the metal
track shown. They're the same length, just expressed in different units. 1h \le 8h 1h H30\le Space-filling model of hydronium ion 1h Electron-dot structure of hydronium ion 1h Electron-dot struc
in order of increasing solubility in water: CH3CH2—OH Ethanol CH3CH2CH2CH2—OH Butanol CH3CH2CH2CH2—OH Hexanol 38. Interference is the phenomenon underlying beats. Therefore, each of the two equations shown above actually represents one-half of an entire process, which is why they are each called a half reaction. The
primary reaction occurs at the negative electrone (anode), where water molecules accept electrons to form hydroxide ions. A sound wave traveling through the ear canal vibrates the eardrum, which vibrates three tiny bones, which in turn vibrate the fluid-filled cochlea. 448 PA R T T W O CH E M I S T RY There are examples of
endothermic reactions that proceed spontaneously, absorbing heat from the environment. How does the mass of the black hole that it becomes? Because granitic rocks are less dense than basaltic rocks, most of the continental crust is above sea level. From PE = ©KE, mgh = 12 mv2, and so v =
1(2gh) = 2[2(10 m/s2)(4.0 m)] = 180 m/s (= 8.9 m/s). Where the dots are most concentrated is where the electrons have the greatest probability of being located: H H H H In a covalent bond between nonidentical atoms, the nuclear charges are different, and consequently the bonding electrons may be shared unevenly. So if you could place Uranus in
a giant bathtub, it would sink. Should a person who wants a long life live at the top or at the bottom of a tall apartment building? CHAPTER 24 1. (c) area and speed. The terminal velocity of a sailcraft is determined not only by opposing friction forces but also by the change in relative wind direction. How many diatomic molecules are represented in
this movie? To get to this point, however, would take, from your point of view, forever. W = (20 N)(3.5 m) = 70 J. C H A P T E R 19 Amines and Alkaloids 19.5 Why are rainforests of great interest to pharmaceutical EXPLAIN THIS O R G A N I C CO M P O U N D S 501 LEARNING OBJECTIVE Review the general properties of amines and alkaloids. The
water entering a water treatment plant is usually a heterogeneous mixture containing suspended solids. 13.4 Radiometric Dating 13. Reverse faults are the result of compressional forces. (a) 400 [ (b) 1000 [ (c) 1600 [ (d) 4000 [ 7. FIGURE 11.7 When the raised ball is released and hits the others, the ball that emerges from the opposite side is not
the same ball that initiated the transfer of energy. Which set of coins has gone through a greater number of tosses? By the next edition of this textbook, the picture may look quite different! TUTORIAL: Fate of the Universe Heavy Elements Neutrinos 0.03% 0.3% Stars 0.6% Free Hydrogen and Helium 4% Dark Energy 73% Dark Matter 23% FIGURE
28.21 Ordinary matter, the stuff from which we and the galaxies we live in are made, makes up not more than 4% of the composition of the universe. Some circuit components are sensitive enough to be "fried" by sparks of static electricity. So the air pressure at the bottom of the bamboo pole would be about 10 N/cm2. Roll a wet skewer stick or
weight (such as a metal nut) attached to a string in some granulated sugar. Elemental sodium, Na, consists of nothing but sodium atoms, which form a soft, silvery metal that can be cut easily with a knife. The core is also very dense, with more than 12 times the density of solid lead. Is the current produced by a common generator ac or dc? Instead,
the reactants merely bounce off each other. Conversely, if the reaction results in the concentration of itself, such a reaction will occur only if an external source of energy is supplied to it. As flowing water slows down, larger particles are the first to be CHAPTER 20 deposited, while smaller particles remain with the flow. We agreed that it would, for it
would be supporting less of the total load. Ordinarily, the input force is applied to the smaller piston and the output force to the large piston. 462 PA R T T W O CH E M I S T RY Aspirin is an acidic molFYI ecule, but not nearly as acidic as the hydrochloric acid, HCl, found in your stomach and used to digest food. Interference is nearly complete, as the
compressions of one speaker fill in the rarefactions of the other. They differ only in their positions relative to one another. Science is a way to teach how something gets to be known, what is not known, what is not known, what is not known, to what extent things are known (for nothing is known absolutely), how to handle doubt and uncertainty, what the rules of evidence are, how to think
about things so that judgments can be made, and how to distinguish truth from fraud and from show. Review the concept of electronegativity in Section 15.6, and rank the acidity of these molecules in order from strongest to weakest: (a) ammonia, NH3; (b) water, H2O; (c) methane, CH4. But from where might this energy come? The bottle that is
three-fourths empty has more head space to fill, but the reserve of dissolved carbon dioxide is less because it contains less seltzer water. Creating this much plutonium generated an estimated 450 billion gallons of radioactive and hazardous liquids, which were discharged into the local environment. Velocity at the beginning = 0 m/s Velocity at the
for an object falling not only for 3 seconds but for any length of time, as long as the acceleration is constant. 4 3 The wave appears cyan because seawater absorbs red light. G and the mass of Earth were measured when a great portion of Earth's surface was still undiscovered. So in 2006 these Plutosized Kuiper belt objects were officially classified as
dwarf planets. To see the gases dissolved in your water, fill a clean cooking pot with water and let it stand at room temperature for several hours. To the delight of Guth, Linde, and many others, the idea of cosmic inflation solved many other mysteries that had been plaquing the Big Bang theory. Try it and be amazed! 49. How high? Would it weigh
more or less on the Moon? Fission and fusion are opposite processes, yet each releases energy. The nearest star beyond the Sun is Alpha Centauri, which is 4.2 * 1016 m away. At what point is its PE at a maximum? Why don't equal masses of golf balls and Ping-Pong balls contain the same number of balls? Why are the seasons on Uranus different
from the seasons on any other planet? In the example of a temperature inversion, is the air stable or unstable? Earthquakes and volcanic eruptions are also a link to the inner workings of our planet. A ruby, for example, is a solid solution of trace quantities of red chromium compounds in transparent aluminum oxide. All animals eat plants (or at least
planteating animals) and therefore have a little carbon-14 in them. c, 8. Today we flip a coin in a high-speed car, bus, or plane and catch the vertically moving coin as we would if the vehicle were at rest. That's because in the freezer, the temperature difference between the pie and its surroundings is greater. The organic matter of the swamps was
buried beneath layers of marine sediments and was eventually transformed into either coal or petroleum. A charged atom is called an ion. A bat chirps as it flies toward a wall. To simplify understanding the process of crystallization in a cooling magma, consider the following analogy. Nevertheless, and quite interestingly, as mentioned at the
beginning of the chapter, it was primarily Newton's laws that got us to the Moon. Because the support force is perpendicular to a surface, it is called a normal force (normal meaning perpendicular). An incandescent lamp emits light of lower average frequencies than sunlight, enhancing any reds viewed in this light. And strictly speaking, it doesn't
"use up" energy but transforms it from one form into another. The ranger aims directly at the monkey, not realizing that the dart will follow a parabolic path and thus will fall below the monkey. TUTORIAL: The Rock Cycle Activity VIDEO: The Rock Cycle 20.10 The Rock Cycle EXPLAIN THIS E How can a metamorphic rock change into an igneous
distance 2 Gravity follows an inverse-square law, as do the effects of electric, light, sound, and radiation phenomena. This gives the molecules greater kinetic energy, which can help their collisions to be more effective. Steel will expand 11 parts in a million for each 1°C increase in temperature; the radius as well as the circumference will expand by
this fraction. You'll better learn physics by going over the same material several times. A black hole is no more massive than the star from which it collapsed. Rank, from beginning to end, the stages in the formation of a hurricane: (a) central low pressure area intensifies, (b) sufficient warm air and high humidity, (c) inward flowing air spirals, (d)
rising warm air creates a central low-pressure area, (e) increase in rotation and speed of wind. As shown in Figure 16.15, there are 3.5 * 1023 molecules of sucrose, but there are almost 10 times as many molecules of sucrose, but there are 3.5 * 1023 molecules of sucrose, but there are almost 10 times as many molecules of sucrose, but there are 3.5 * 1023 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but there are 3.5 * 1024 molecules of sucrose, but the 3.5 * 1024 molecules of sucrose
reactant molecules. W Warm Cold Hot F I G U R E 6.1 Can we trust our sense of hot and cold? If mass m is expressed in terms of density r, where r = m/V, and each term is divided by V, Bernoulli's equation reads: 12 rv2 + rgy + p = constant. In water, the speed in air; in steel, about 15 times its speed in air; in steel, about 15 times its speed in air. m1m2 reads: 12 rv2 + rgy + p = constant.
39. Which of these electromagnetic waves has the lowest frequency? What happens to the radial distance of the event horizon as more and more mass falls into the carbonyl carbon bonded either to one hydrogen and one carbon or to two
hydrogens. What would be the weight of a 10-kg object on the Moon and on Earth? Aristotle's aim was to systematize existing knowledge, just as Euclid had systematized geometry. The old-fashioned farm-type pump shown in Figure 5.27 operates by producing a partial vacuum in a pipe that extends down into the water below. Table 1.1 compares
some speeds in different units. 3.5 Work-Energy Theorem EXPLAIN THIS How much farther will you skid on wet grass if you run twice as fast? As the water dries out, evaporite minerals precipitate and are left behind. Classify each change as physical or chemical. F I G U R E 2 8 .1 3 The trajectory of a flashlight beam is identical to the trajectory of a
baseball "thrown" theoretically at the speed of light. 49. Then other transformers reduce the voltage before supplying it to homes, offices, and factories. Arithmetic formulas used for converting from one temperature scale to the other are common in classroom exams. Taking the charge is q 2 = k 9 * 109 Nm2/C2 square root of this gives q = 2.8 * 10-6
C, or 2.8 microcoulombs. It is a measure of how much mass occupies a given space; it is the amount of matter per unit volume: mass Density = volume F I G U R E 5 .1 When the volume of the bread is reduced, its density increases. Temperature is one thing; transfer of thermal energy is another. A magician places an aluminum ring on a table,
underneath which is hidden an electromagnet. The first is associated with the final stages of magma crystallization—magma generally contains from 1% to 6% water. Sound waves of frequenAmplitude cies lower than 20,000 Hz (b) are
called ultrasonic waves. In any case, the direction of the force is always perpendicular to the magnetic field lines and the velocity of the charged particle (Figure 9.16). Earth is farther away from the Sun in June and closest in December. Show that it takes 5.0 s for the bus to slow from 10.0 m/s to a position of rest. It is tempting to blame technology
itself for such problems as pollution, resource depletion, and even overpopulation. Tension causes the hanging wall to drop downward along the fault (Figure 21.34). The interaction is between your hand and the wall. However, we can purify water to meet our needs. Newton's third law,
the law of action-reaction: Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first. 7 Polymers most versatile of all atoms. He realized that the Moon falls in the sense that it falls away from the straight line it would follow if there were no forces acting on it. Show that when his potential
energy reduces to 4000 J, his kinetic energy is 6000 J. Pressure * volume for a F I G U R E 5 .1 8 When the density of gas in the tire is increased, pressure is increased, pressure is increased. The parts of the wire that brush against these contacts are called brushes. This is perhaps the result of changes in the direction of electric currents within Earth. 36 PA R T O N E P H Y
S I CS 96. Once ice is formed, temperatures lower than 4^{\circ}C can extend down into the pond. Pink flares from the chromosphere may also appear. The retina is not uniform. m m F - f 12.0 N - 6.0 N 6.0 N 1.5 N = = = = 1.5 m/s2. Very tiny particles act in a similar way. Does the periodic table explain the shell model, or does the shell model explain the
periodic table? If you split an iron nucleus, the products lie to the left of iron on the curve—also a higher mass per nucleon. CO2 and H2O react to form carbonic O D D - N U M B E R E D S O LU T I O N S acid, H2CO3. Atmospheric pressure is exerted on both sides of a window, so no net force is exerted on the window. Solution: (a) From the
impulse-momentum equation, Ft = @mv, where in this case the egg ends up at rest, @mv = mv, and simple algebraic rearrangement gives F = mv/t. Going from first to last, rank these steps: (a) air rises to a level where the condensation
rate equals the evaporation rate. 3 6 The color green on a printed page consists of cyan and yellow dots. Furthermore, its color is shifting toward ultraviolet and beyond. The high part of one wave simply fills in the low part of another. In short, 602 billion trillion, as discussed on the next page, is an inconceivably large number. The magma becomes
depleted in the constituents of minerals that have already crystallized and enriched in the caprylaldehyde. (a) Shield volcanoes, such as Mauna Loa, have broad, gentle slopes that average between 1° and 10° (from the horizontal).
Cite an example in which a force is exerted on an object without doing work on the object. Hewitt 61: Steve Bloom Images / Alamy 63: Edward Knisman/Photo Researchers, Inc. When a current-carrying wire is placed in a
strong magnetic field, no force acts on the wire. Note that the curvature of the ball's path is the combination of horizontal motion, which undergoes acceleration due to gravity. Only then was Earth regarded as a planet among others. Bumps the size of atoms on the surface cause the needle to move up and
down. The same is true of atoms and molecules. Can the weight of the barbell on his hand. (b) The waveform on the oscilloscope screen is a graph of pressure against time, showing how air pressure near the microphone rises and falls as
sound waves pass. VIDEO: Newton's Law of Inertia VIDEO: The Old Tablecloth Trick VIDEO: Toilet Paper Roll VIDEO: Inertia of a Cylinder VIDEO: Inertia of a Cylinder VIDEO: Inertia of an Anvil VIDEO: Inertia of a Cylinder VIDEO: Inertia of a Cylinder VIDEO: The Old Tablecloth Trick VIDEO: The Old Tablecloth Trick VIDEO: Inertia of a Cylinder VIDEO: Inertia of a Cy
definition of KE. THINKANDSOLVE (MATHEMATICALAPPLICATION) Refer to the Figuring Physical Science box on page 686 for the following two problems. Earth science author Leslie is seen at age 16 illustrating the wonderful idea that we're all made of stardust on page 318. Node ost of the sounds we hear are noises. As
mentioned earlier, rubies and sapphires differ in color because of the impurities they contain. Huge Europe mountain ranges running down the 500 m.y.a. middle of the Atlantic, Pacific, and Indian Oceans were discovered (Figure 21.16). Set up two pocket mirrors at right angles and place a coin between them. That's because your distance from
Earth's center is greater. So in what sense can we say that boiling is a cooling process? The smell and taste of the lemon also help to mask any additional fishy odors. If it were cut off, the shuttle would move in a straight-line path at constant speed (constant velocity). Express the numeric value of the formula mass of any compound in grams, and a
sample having that mass contains 6.02 * 1023 molecules of that compound. (b) What happens to the support force on the feet of you and your friend? Both of these calendars were cyclical and couldn't account for succeeding years. Since current = voltage/resistance, we can write the formula for power as 35. Search the Internet to find what major
rivers in the world no longer reach the oceans. Cooling a 100C saturated solution of NaNO3 to 20C causes 78 g of the solute to precipitate. At position 2, hang a bead from a string that is 4 cm long. Why isn't the same kind of rock at Earth's surface warm to the touch? Heavier elements were produced after many of these early stars exploded in
supernovae. This thousand-year-old pulsar is relatively young. This is the atomic mass unit, amu, where 1 atomic mass unit is equal to 1.661 * 10-24 gram, which is slightly less than the mass of a single proton. 6 Electric Current 8. Whereas the filling of hot apple pie can burn your tongue, the crust does not, even when the pie has just been removed
from the oven. Astronomers find evidence of massive amounts of this stuff surrounding each galaxy. The spring pushes up on your hand with as much force as you exert to push down on the spring. When heat transfer is zero, or nearly so, we have an adiabatic process. This was the beginning of modern science. • The text of all chapters has been
edited for accuracy and better readability and also updated to reflect current events, such as the nuclear power plant disaster following the 2011 Japanese earthquake and tsunami, the Gulf oil disaster, and the discovery of Fermi clouds arising from the center of our Milky Way galaxy. Power = Fd/t = (2 \text{ J})/(1 \text{ s}) = 2 \text{ W}. Weightless Being without a
support force, as in free fall. It describes the temperature changes of the air that a rising air parcel passes through. (b) has a structure much like an atom. This flow of electrons is an electric current, which is a form of kinetic energy that can be harnessed for useful purposes. The snow doesn't provide them with energy—it simply slows down the loss
of body heat that the animals generate. Students should be directed to do this only under careful supervision. The final result is that the hydronium-ion concentration is higher than the hydronium-ion concentration. Likewise, at midnight, the new Moon would be absent. Rank the four pairs, from highest to lowest, on the basis of the height of the peak
that results when the centers of the pulses coincide. It is interesting to note that the equation for constant speed, v = d/t, guides our thinking about the crucial factor in this problem—the time. The symbol of resistance and the constant speed, v = d/t, guides our thinking about the crucial factor in this problem—the time. The symbol of resistance are the constant speed, v = d/t, guides our thinking about the crucial factor in this problem—the time. The symbol of resistance are the constant speed, v = d/t, guides our thinking about the crucial factor in this problem—the time. The symbol of resistance are the constant speed, v = d/t, guides our thinking about the crucial factor in this problem—the time. The symbol of resistance are the constant speed, v = d/t, guides our thinking about the crucial factor in this problem—the time.
physical change? (b) Actually, any element of the periodic table can form a covalent bond. The ridge area is high compared to the surrounding seafloor because of the lift it gets from rising mantle rock—rock that is convecting upward from the asthenosphere below. The perturbations of Uranus led to the discovery of Neptune. (b) That would be too
much of a coincidence. 12.5 Physical and Conceptual Models 13. It is a carrier of energy that requires a source. 100°C FIGURE 16.21 The solubility of sodium nitrate is 165 g per 100 mL at 20°C. Methane reacts with oxygen to form carbon dioxide and water. FIGURE 19.6 Carbon has four valence electrons.
Some wave patterns created by sources moving at various speeds are shown in Figure 10.35. In addition, many mountain chains across the ocean. What are streamlines? After turning the turbine, it is returned to the cavity for reuse. The fact that the giants are both much cooler and much brighter than
the Sun tells us that these stars must also be much larger piston supports a 500-kg load—50 times the load on the smaller piston! This is something to write home about, for we can multiply forces using such a device. TA B L E 1 7. Second, Bohr recognized that when an atom absorbs a photon of light, it is absorbing
energy. Mastering currently has more than 1.5 million active registrations with active users in 50 states and in 41 countries. In the inner core, the iron and nickel are solid. You push still harder and the desk moves. N H H N F F H F Ammonia Nitrogen Trifluoride 58. It catches the worm guite unaffected by the motion of its total environment. Recall
Figure 2.9, in which heavy and light bricks fall with the same acceleration because both have the same acceleration from which the wind comes and its feathers indicating wind speed. Therefore, any [email protected] object in air is buoyed up with a force of 12 N. When in life do
we have the opportunity of simultaneously narrowing our focus while expanding our horizons? Tie some string to a weight and lower the string into the solution is accomplished by magnetic coils that run along a guideway. This results in a situation in which the two fluorine atoms are mutually attracted to the same two
electrons. So what is the physics that explains John's feat? They are the first minerals to crystallize. Check it out! How might this line look different if viewed from the North Pole versus the equator? Tension is the dominant force where plates move away from each other. So fluorite scratches calcite. An example is
eon—Rodinia, glaciation, single-celled life, O2 and O3. By translational we mean to-and-fro linear motion. FIGURE 21.34 Fault plane A normal fault. (3) More time, burial, heat, and pressure lead to the formation of bituminous coal—a soft, black, high-energy coal used for power production. Newton's law of gravity as written applies to particles and
spherical bodies, as well as to nonspherical bodies sufficiently far apart. The farther away the wall, the weaker the echo. The Sun will expand into a red giant before ultimately becoming a white dwarf. (b) Nucleons on opposite sides of a larger nucleus are not as close to one another, and so the attractive strong nuclear forces holding them together
are much weaker. If Earth spins faster, day length shortens. This illusion led the ancient Greeks and others to conceive of the stars as being attached to a gigantic sphere surrounding Earth, called the celestial sphere. It would be in orbit. Further, the predictions of astrology are not borne out; there just is no evidence that astrology works. A sample of
hydrogen gas has a temperature of 0°C. Parrots, like humans, use their tongues to craft and shape sound. It is common to describe sound and radio by frequency and light by wavelength. In metamorphism, change occurs instead by recrystallization of preexisting minerals or by mechanical deformation of rock. Is the head of a politician really made of
99.999999% empty space? The incident and emerging speeds of light are the same. The distance between these two marks measures your vertical leap. You aren't aware of it only because your weight is so much greater. The more kinetic energy something has, the more work is required to stop it. In partial melting, rocks and minerals with a low
Figure 16.9, results in a visible cone as the light is reflected by the suspended components. Which is stronger: the covalent bond that holds atoms together within a molecule or the electrical attraction between two neighboring molecules? Eventually, with repeated freezing, cracks can widen to split the rock! FYI Forces of ice on rock Ice FIGURE
pair of interacting objects. Your friend sees the light red-shifted. On the other hand, structures built on soft mud close to the bay suffered severe damage or collapse. 226 PA R T O N E P H Y S I CS FIGURE 9.23 Voltage is induced in the wire loop whether the magnetic field moves past the wire or the wire moves through the magnetic field. When
these creatures die, they settle to the bottom and form layers of chemical sediment. During this ultrabrief speck of time, the space within the universe inflated by a factor of 1030. (If the electromagnetic coil attracted your magnet instead of repelling it, energy would have been created from nothing and the law of energy conservation would have been
violated. How does the terminal speed of a parachutist before opening a parachutist before opening a parachutist before opening a parachute compare to the terminal speed after? Is it true that magnetism about planet Earth shields us from harmful cosmic rays? A police officer pulls you over for speeding. Because the masses of water are the same, the final temperature is midway, 30°C. A solution of a strong
acid has more ions in solution and can conduct electricity better. A dirigible or huge balloon that weighs 100 tons of air. 8 perpendicular orientation shown in Figure 17.9, nitrogen monoxide does not INTERACTIVE FIGURE form. The more accurate a conceptual model, the more accurately it predicts the behavior of the
system. Two stars that appear very close together are on the same line of sight, but they may actually be an enormous distance apart and would not appear close together when viewed from another location. Hewitt 65: (bottom) Paul G. Matter in all forms is made up of constantly jiggling particles—namely, atoms and/or molecules. Caverns, caves, and
sinkholes. Partial tone One of the frequencies present in a complex tone. To account for this inconsistency, Wegener proposed that Pangaea existed 300 million years ago, with South Africa located over the South Pole. How does the wave model of electrons orbiting the nucleus account for the fact that the electrons can have only discrete energy
values? After all, the gravitational force exerted by celestial bodies on a person is smaller than the gravitational force exerted by objects making up the earthly environment: trees, chairs, other people, bars of soap, and so on. Seafloor spreading The moving apart of two oceanic plates at a rift in the seafloor. The Btu is defined as the amount of heat
required to change the temperature of 1 lb of water by 1°F. (c) neither absorbs nor releases energy. The conductivity of wood is relatively low whatever the temperature—even at the stage of red-hot coals. Structural isomers Molecules that have the same molecular formula but different chemical structures. The average person in the United States is
exposed to about 360 mrem a year, as Table 13.1 indicates. The most common dry-cleaning solvent is perchloroethylene, C2Cl4, which is gentle on the clothing and can clean a full load in under 10 min. Note their varying distances in light-years (ly). You can't reach its end. What beat frequencies are possible with tuning forks of frequencies 256, 259
and 261 Hz? The neutron has about the same mass as the proton, but it has no electric charge. While scientific truth is a matter of public scrutiny, religion is a deeply personal matter. In this letter, you may use an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation or two, as long as you make it clear that an equation of the equati
possible? 4 The Periodic Table 12. This gap in the roadway of a bridge is called an expansion joint; it allows the bridge to expand and contract. In the following reaction sequence for the catalyst: nitrogen monoxide or nitrogen dioxide? 4 Determining Physical and
Chemical Changes 14. How is Coulomb's law similar to Newton's law of gravitation? How do clouds form? These bonds are in order of increasing polarity from left to right, a trend indicated by the larger and larger crossed arrows and d-/d+ symbols. It appeared in print in 1687 and wasn't printed in English until 1729, two years after his death.
Science and religion have similarities also. in an electric circuit is VIDEO: Ohm's Law The gas inside an incandescent lightbulb is a mixture of nitrogen and electric charges. in the wrong orientation. So no energy is released. The tension in the string supporting the 10-kg
block is 100 N (which is the same all along the string). The frequency of the most intense radiation is called the peak frequency f and is proportional to the emitter's Kelvin temperature: f & T If an object is hot enough, some of the radiant energy it emits is in the range of visible light. The bar can be demagnetized by striking it when it is in an east-
west direction. At times in Earth's history, shallow seas covered the continental land, allowing carbonate rocks to be deposited. If air resistance is neglected, any projectile will fall 5t 2 meters below where it would have reached if there were no gravity. The greatest practical difference is the amount of fuel involved: a mere kilogram of uranium fuel,
smaller than a baseball, yields more energy than 30 freight-car loads of coal. Wave amplitude is increased in constructive interference, reduced in destructive interference in destructive interference in destructive interference in destructive interference in destructiv
its momentum changed? Is it possible to see an atom using visible light? Rather, sheet-structured minerals, such as the micas, grow and orient themselves with their sheets perpendicular to the direction of maximum pressure (Figure 20.34). Imitation vanilla does not taste the same as natural vanilla extract, however, because, in addition to vanillin,
many other flavorful molecules contribute to the complex taste of O CH3 O C C C Ketone group FIGURE 19.21 Aldehydes are responsible for many familiar fragrances. We now see an additional condition. We get 60 amu * 100% = 34.8% 172 amu which rounds off to 35% Since we now know the mass percentage of silica
in olivine, we can figure out how much silica was removed from the magma when 325 kg of olivine * 0.35 = 114 kg silica Now that the olivine has crystallized, the mass percentage of silica in the remaining magma is less than 50%, but how much less? F L U I D M E CH A N I CS 135 LEARNING OBJECTIVE Relate changes
in the speed of fluid flow to changes in pressure. These chains become interlocked in a rigid three-dimensional network that lends considerable strength and durability to the polymer. According to the pelonets start forming before or after the Sun ignited? LEARNING OBJECTIVE Describe the process by which small nuclei can
join together, leading to the production of energy, such as occurs in the Sun. 714 PA R T F O U R ASTRONOMY FIGURE 26.7 The pearly white solar corona is visible only during a solar eclipse. 12.7 The Quantum Hypothesis EXPLAIN THIS Why do atomic spectra contain only a limited number of light frequencies? True or False: A helium balloon here
on Earth pops, releasing direct remnants of the Big Bang. This is the rubbing alcohol you buy at the drugstore. 27 The square on the top reflects all the colors illuminating it. In a perfectly inelastic collision, the objects stick together. What two minerals make up most of the sand in the world? Yes; limestone is formed predominantly from the shells of
dead marine organisms. Many students make the common error of thinking that no reaction will occur if the proper ratios of reactants are not provided. Propane, C3H8? The Great Red Spot (lower left), larger than Earth, is a cyclonic weather pattern of high winds and turbulence. Does more current "flow" into a lightbulb than out of it? Show that a
freely falling rock drops a distance of 45 m when it falls from rest for 3 s. If it were cooled to 273°C below zero, it would apparently have no pressure at all. Eternal inflation A model of the universes in its wake. The
signals, which are detected by sensors, are then analyzed by a computer to reveal varying densities of hydrogen atoms in the body and their interactions with surrounding tissue. The soap itself, then, is slightly alkaline. The answers to these questions involve an understanding of mixtures. It makes nature simpler and easier to understand. Can you
account for the other resulting colors that appear? Because of dispersion, there are rainbows! Rainbows Sunli ght 42° 40° let Vio Re d F I G U R E 11. Wings come in a variety of designs. 14.5 Elements to Compounds 20. Similarly, the space around a magnet is energized with a magnetic field, and the space about an electrically charged object is
energized with an electric field. By how much does the current decrease? This rising of air is accompanied by the sinking of cooler air from above. Fuel cells are by far the most efficient means of generating electricity. What is the wavelength of the lowest sounds we can hear, about 20 Hz? 3 5 Carlos Vasquez displays a variety of colors when he is
illuminated by only red, green, and blue lamps. HiH HiC HiN HiO HiF CiO H i Cl CiC SELEC TED BOND ENERGIES Bond Energy (kJ/mole) 436 414 389 464 569 351 431 347 NiN OiO Cl i Cl C"O N"O O"O C,C N,N 159 138 243 803 631 498 837 946 By convention, a positive bond energy represents the amount of energy
absorbed as a bond breaks, and a negative bond energy represents the amount of energy released as a bond forms. 3 May 6 Aug. (a) F I G U R E 1 6 .1 2 Solutions may occur in (a) the solid phase, or (c) the gaseous phase. We interact with it directly. Air masses are divided into six general categories, according to the type of land
or water they form over and the latitude at which their formation occurs (Table 25.3 and Figure 25.9). (Hint: About 90% of the mass of a newly launched rocket is fuel.) 98. Although the voltage of the charged balloon is high, the electric potential energy is low because of the small amount of charge. E lectrical force, like gravitational force, decreases
inversely as the square of the distance between charges. High pressure compresses mineral grains against one another, making the rock stronger, more difficult to break, and more prone to plastic flow. By how much? Big Bang Present Future TIME 1016 years, planets and stars will be flung from their orbits because of random collisions, most then
falling into supermassive black holes and the rest forming scattered stellar debris. In a zone of compressional faulting, the hanging wall is pushed up relative to the footwall. A toaster has a heating element of 15 \( \frac{1}{4} \) and is connected to a 120-V outlet. VIDEO: Plutonium 334 PA R T T W O CH E M I S T RY barium, an element with about half the mass of
uranium. When it speeds up in traveling from one medium to another, as it does in going from water to air, it bends away from the normal. If a box is dropped from a high-flying jumbo jet, it too has the tangential speed of the jet. Part of whatever pressure you add to the water is transmitted to the hungry crocodiles, via Pascal's principle. If this
happens slowly, the reaction rate is low. Galaxies recede from one another because the space between them is expanding. If so, you may have marveled at its perfect geometric form (Figure 20.5). The copper salts can then be transformed back into copper metal when exposed to an iron nail. His interests included not only meteorology and
climatology, but also astronomy, geology, geophysics, oceanography, and paleontology. This shows that the petal has the ability to reflect green light, but it cannot reflect other colors. 28.3 General Relativity EXPLAIN THIS What is the downward
acceleration of a light beam at Earth's surface? Nails sticking to a magnet is understandable. ANTHRACITE The formation of coal. An example is oxygen, O2, in water. Why do troops "break step" when crossing a bridge? This work, according to E = mc 2, adds mass to the system, so the separated nucleons are more massive than the nucleus from
which they came. Things at rest have another kind of energy—potential energy. Like humans, owls locate sound sources by using the fact that sound waves often reach one ear milliseconds before the other. O ne of the most important facts about fluid pressure is that a change in pressure at one part of the fluid is transmitted undiminished to other
parts. If the polonium emits an alpha particle, the atomic number decreases by 2 and becomes 82, and the atomic mass decreases by 4 and becomes 214. If we define PE = 0 at the bottom of the swing, the place where KE is half its maximum value, and KE = PE at this point. What is expected to
happen to the Sun in its old age? A 6-V battery provides 6 V across the top two lamps. Because it is amphoteric, water can react with itself. If nonfloating material is carried, then balance and the associated low energy input would be problematic. Hewitt 484: (top right) Pearson Education/Pearson Science 484: (bottom right) Pearson
Education/Pearson Science 489: John Suchocki/Paul G. A mineral is a naturally formed, inorganic, crystalline solid composed of an ordered array of atoms and having a specific chemical composition. The recharging of a car battery is an example of electrolysis. For nonperpendicular angles, v in this relationship must be the component of velocity
perpendicular to B. Hold a pencil tip to each electrode while submerging the opposite ends of the pencils into salt bridge Cu Semiporous Fe2 \leq Cl\geq Fe Cl\geq Cu2 \leq Cu2 
the electric circuit. This exerts friction on the fluid and dissipates some of its energy is released either as molecular kinetic energy (heat) or as light (the flame). What does it not multiply? (Hint: See Activity 35.) 121. 3 Reflection 11. 633: (bottom) American Museum of Natural History 636: D. 6 A light wave
incident on a pane of glass sets up vibrations in the molecules that produce a chain of absorptions and re-emissions, which pass the light energy through the material and out the other side. Two electrons fit into the first shell. Like vibrations in a bell, primary Primary wave (a) waves move out in all directions from their source. What types of
hydrocarbons are more abundant in higheroctane gasoline? When the temperature of ice-cold water is increased air pressure and heat 2. Increased air pressure CHAPTER 5 produced by an air compressor is transmitted through the air to the surface of oil in an
underground reservoir. So if 1 mole of sucrose is added to 1 L of water, the result is more than 1 L of solution. Aluminum occurs naturally bonded to oxygen in an ore called bauxite. Dolomite, CaMg(CO3)2, is also a common carbonate mineral. To understand fluid-induced melting, we can use the behavior of water as an analogy once again. .Sb. . The
result of osmosis is a buildup in volume of the salt water and a decrease in volume of the fresh water. 5 Physical and Conceptual Models 12. Hewitt 727: Dennis DiCicco 729: (top) NASA/Goddard Institute for Space Studies 729: (middle) ESO/S. A piece of plastic tape coated with iron oxide is magnetized more in some parts than in others. To account
for the flatness of the universe, there needs to be large amounts of mass-energy to make up for the deficiency of dark and ordinary matter. Isopropyl alcohol, also known as rubbing alcohol, is very toxic if ingested. It would be humorous to scrape the residue from your boileddown drinking water into sealable containers labeled as drinking water from
your particular region, such as "Rocky Mountain Drinking Water." Think O D D - N U M B E R E D S O LU T I O N S of the potential market. It turns out that the change of potential energy of a 1-km body moved from the surface of Earth to an infinite distance is 62 million J (62 MJ). The stars appear to turn around an imaginary north-south axis once
every 24 hours. Salt, sodium chloride, is a compound. Volcanoes are vents where magma rises to Earth's surface and erupts as lava. Oceanic-continental convergence (Figure 21.23b) 3. The white light from the Sun is a composite of all the visible frequencies. What is an adiabatic process? * A kilogram is not a unit of force but a unit of mass. Blasts of
air from tiny holes provide a friction-free surface for the carts to glide on. Explain in terms of momentum conservation. 10 The Rock Cycle system that can be organized into "spheres"—the geosphere, hydrosphere, and atmosphere atmosphere, and atmosphere atmosphere. The needle aligns itself with the horizontal component of Earth's magnetic field. See also Oxidation-reduction reactions
Reefs, coral, 657 Reflection diffuse, 271 of light, 276 of radiant energy, 170 of sound, 244-245 Refraction of light, 272-275 of sound, 245 wave, 654-655 Regional metamorphism, 546-547 Relative humidity, 683 Relativity, 768 cosmic inflation and, 775-777 general theory of, 777-781 principle of equivalence and, 778 special theory of, 781 Religion,
science and, 7-8 Rem, 324-325 Research, basic vs. Which should weigh more: 100 mL of flat seltzer water at 20°C or the same 100 mL of flat seltzer water brought to 80°C? If you shake it back and forth, the wave vibrates in a horizontal plane. Perhaps most intriguing of all, however, is Europa, whose surface is made of frozen water. When the can
comes to an abrupt stop, the water forces the submerged Ping-Pong ball to shoot into the air. (a) Diamond, the hardest substance known, has a tightly packed symmetrical structure. Hewitt City College of San Francisco John Suchocki Saint Michael's College Leslie A. Oops, be careful. That's how science grows. Being intrusive, plutonic rocks can be
studied only after they are exposed by uplift and erosion at Earth's surface. If the cannonball is fired fast enough, however, the curvature matches the curvature matches the curvature energy. What is the difference between a silicate mineral and a
nonsilicate mineral? 720 PARTFOUR RTFOUR RTF
Net force couldn't be zero. For a good balance of these two important ions, you might inquire about commercially available half-and-half mixtures of sodium chloride and potassium chloride, such as the one shown here. If the little work done by friction forces is small enough to neglect, the work input equals the work output: F d F d d=F F d FIGURE
stars is due to the rotation of Earth. G-2 G L O S S A RY Beta particle An electron emitted during the radioactive nucleus. The unit of electrical resistance is the ohm, \tau. When the field is made to oscillate, the H2O molecules oscillate also—and quite energetically when the frequency of the waves matches the natural rotational
frequency of the H2O. (The increase in speed depends on how big the increase in area is compared to the increased discharge.) 55. Increased tenfold? 450 PA R T T W O CH E M I S T RY 36. 4 Solubility 16. If a person's ideas and view of the world are no different after a lifetime of varied experience, then that person either was miraculously blessed
background radiation and is taken as strong evidence of the Big Bang (Figure 28.5). zap! We have all seen birds perched on high-voltage wires. (d) none of these 3. This union of terrestrial laws and cosmic laws is called the Newtonian synthesis. Can you see why? Because the U-235 isotopes are so highly diluted with U-238, an explosion like that of a
nuclear bomb is not possible. By doing so you extend the time during which your momentum decreases to 10 to 20 times that of a stiff-legged, abrupt landing. They do so because of their high electron pulling power). Instead it soon falls to Earth's surface. FIGURE 10.32 INTERACTIVE FIGURE 70.32 I
toy wagon. F I G U R E 1 0 .1 5 The 14-week-old fetus that became Megan Hewitt Abrams, who is more recently seen on page 216. When the submarine is submerged, the buoyant force equals the submarine's weight plus the weight of water. Why aren't the
atomic masses given in the periodic table whole numbers? Before the advent of Islam, Arab nations developed mathematics and learned about the production of glass, paper, metals, and various chemicals. The pointer is calibrated to show your weight. Water in the atmosphere reacts with carbon dioxide to form carbonic acid: CO2(g) + H2O(/) h
H2CO3(aq) Carbon dioxide Water Carbonic acid, as its name implies, behaves as an acid and lowers the pH of water. For an appliance that converts electric energy directly to thermal energy, overheating occurs when excess voltage is applied. 160 PA R T O N E P H Y S I CS A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 31
Greater angles to the propelling medium (wind for the boat, water wave for the surfboard) result in greater speeds. CHAPTER 20 F I G U R E 2 0 .1 2 Minerals Classification of common rock-forming minerals. Clastic Sedimentary Rocks Sedimentary Roc
clastic sedimentary rocks. Don't confuse radio waves with the sound waves they can make. What force allows dark matter to clump? A mineral with high solubility dissolves easily. Tangential speed is a different story; since she is twice as far from the axis of rotation, she moves twice as fast—4 m/s. Why are exothermic reactions self-sustaining? The
interplanetary forces causing this wobbling are called perturbations. 16 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Establish Galileo's influence in understanding motion. What are the scale readings? Glaciation was the cause. After passing through this membrane, the aspirin finds itself in a less acidic environment where it can finally donated
its hydrogen ion. If world population doubles in 40 years and world food production also doubles in 40 years, how many people then will be starving each year compared to now? Or, when a moving car slows, work is done to reduce its kinetic energy. If the acceleration of planet A is unnoticeable in part (a), then it is more noticeable in part (b), where
the difference between the masses is less extreme. Work-energy theorem: W g QKE 47. To illustrate how bodies of air behave, imagine a body of air enclosed in a very thin plastic garment bag—an air parcel. Electron-dot structure A shorthand notation of the shell model of the atom, in which valence electrons are shown around an atomic symbol.
Induced dipole-induced dipole attractions help explain why natural gas is a gas at room temperature but gasoline is a liquid. This moment of dramatic expansion is known as cosmic inflation. How is the melt different from the original "rock"? During transportation, especially by water, the various particles collide with one another and break. The half
containing the fault surface where someone could stand is the footwall block. Solution: (a) We're asked to find the acceleration. Show that if 4 kg of this refrigerant were allowed to vaporize in a refrigerant were allowed to vaporize in a refrigerant were allowed to vaporize in the deep interior of the Sur
fuse the nuclei of hydrogen atoms together to form helium nuclei. If electric charges are set into vibration in the range of frequencies that match those of light, waves are produced that are light! Maxwell discovered that light is simply electromagnetic waves in the range of frequencies to which the eye is sensitive. If you score less than 7, consider
studying further before moving on. To convert to kilometers, divide by the number of centimeters in a kilometer, which is 100,000. Rose-colored quartz results from small amounts of iron. CHECKPOINT Distinguish the main functions of primary, secondary, and tertiary wastewater
treatment. So the blue stars in the night sky have higher temperatures than the red ones. After beta emission from polonium, the atomic number increases by 1 and becomes 85, and the atomic mass is unchanged at 218. The result is a sea breeze. The wheel always remains balanced as it rotates and lifts boats 18 m from a lower body of water to a
higher one (Figure 5.17). The exhaust that comes from an automobile engine, for example, contains a wide assortment of pollutants, such as nitrogen monoxide, carbon monoxide, and uncombusted fuel vapors (hydrocarbons). * In mathematical form: 12 mv2 + mgy + pV = constant (along a streamline), where m is the mass of some small volume V, v
its speed, g the acceleration due to gravity, y its elevation, and p its internal pressure. A familiar example is the chef who turns a ball of pizza dough into a disk by spinning it on his hands. Most mineral samples do not display their crystal forms. (d) What is its velocity 1 s after it reaches its highest point? In contact metamorphism, water-rich, low-
temperature minerals are found far away from the contact zone. As shown in Figure 12.8, the atomic masses listed in the periodic table are in atomic masses units. The hydrogen and oxygen are both gases at room temperature, and they can be seen as bubbles rising to the surface. You simply point the thermometer at something whose temperature you
want, press a button, and a digital temperature reading appears. The Andromeda galaxy is moving toward the Milky Way galaxy at a rate of about 300,000 mi/h. What trends do you foresee in company retirement plans? Because time is equal and opposite, the impulses, Ft, are also equal and opposite. Although molecule-to-
molecule attractions are relatively weak, their effects on the physical properties of substances are most significant. The large down-dropped valleys generated by this process are called either rifts or rift valleys (Figure 21.22). But where did the warm air go? We find that light originates from the accelerated motion of electrons. The first outer planet
is Jupiter, which on the scale mentioned would be the size of a softball more than half a kilometer away. To do so can be fatal. Methane in the upper atmosphere absorbs red light, giving Uranus its blue-green color. A Magnetic compasses show the circular shape of the magnetic field surrounding the
current-carrying wire. Active galactic nucleus The central region of a galaxy in which matter is falling into a supermassive black hole and emitting huge amounts of energy. 6 The tip of a heater element submerged in water produces convection currents, which are revealed as shadows (caused by deflections of light in water of different temperatures)
Reflections from the gasoline and water surfaces interfere, canceling colors and producing their complementary colors (discussed in the next chapter). When you push a crate across a floor you're doing work. Wood is a better insulator than glass, yet fiberglass is commonly used as an insulator in wooden buildings. This phenomenon is illustrated in
Figure 15.32. What element behaves as the oxidizing agent? Suppose you wish to lay a level foundation for a home on hilly and bushy terrain. By doing so, they become paired with an electron from another atom. From sodium's position in the table, we can Empty Filled valence space
see that a sodium atom's single valence electron is shell not held very strongly, which explains why it is so F1- (negative ion) F easily lost. Sugar is very polar, as evidenced by its solubility in water. Swing a buzzer of any kind over your head in a circle. The voltage across the second lamp would be 4 V, so the sum of the two is 6 V. Which statement is
correct? When the hydronium-ion concentration of a solution is 1 * 10-10 M, what is the pH of the solution? But from afar, we know that Earth's surface is not flat—it is curved. (Vector quantities take direction into account, so if upward forces are positive, downward ones are negative; the resulting sum is equal to zero.) In Figure 1.12 we see the
forces of interest to Burl and Paul on their signpainting scaffold. Limestone, made up of the mineral calcite (CaCO3), is the most abundant carbonate rock. Show that the mass of ice that melts is 50 g. Later it was found that electrons are neither created nor destroyed but are simply transferred from one material to another. The wheels roll from a
smooth sidewalk onto a grass lawn. Law of conservation of momentum In the absence of an external force, the momentum of a system remains unchanged. In reference to human nature, Jerome Delli Priscoli, a social scientist with the U.S. Army Corps of Engineers, stated, "The thirst for water may be more persuasive than the impulse toward
conflict." Do you agree or disagree with his statement? Resonance is not restricted to wave motion. The masses of galaxies range from about a millionth the mass of our galaxy to some 50 times more. Includes index. For now, we focus on the human-made polymers, also known as synthetic polymers, that make up the class of materials that are
commonly known as plastics. Hydrogen represents stored energy, like a battery. EXPLAIN THIS F or the purposes of a simplified understanding of how atoms behave, we turn to the shell model, first made popular by the noted chemist and twotime Nobel laureate Linus Pauling (1901–1994). Most, more than 90%, of the electric energy fed into an
incandescent lamp goes directly to heat. Electron flow Voltage source FIGURE 8.30 INTERACTIVE FIGURE A simple parallel circuit. So we gain additional minutes of daylight each day. 12.8 Electron Waves 22. A pair of tones of the partials. (c)
Soap is made by reacting bases with animal or vegetable oils. Hess's hypothesis of seafloor spreading helped establish a mechanism for Wegener's hypothesis of continental drift. Earth's curvature, dropping 5 m for each 8-km tangent, means that if you were floating in a calm ocean, you'd be able to see only the top of a 5-m mast on a ship 8 km away.
The higher the frequency of the wave, the shorter its wavelength.* Light is energy carried in an electromagnetic wave emitted by vibrating electrons are good conductors of heat. 418 PA R T T W O CH E M I S T RY Naturally occurring water is FYI alive with
bacteria, which break down organic matter. Human elevation didn't occur until the Sun, viewed positively, took a center position. Viewing Andromeda is best when the Pegasus box is directly overhead. Charges must also balance in compounds containing ions that carry multiple charges. Why is an echo weaker than the original sound? The
gravitational force between the two masses was measured by the weight needed on the opposite FIGURE 4.4 Von Jolly's method of measuring G. What happened to this thicker atmosphere? (b) be saturated. How high does it stand above ground level? FIGURE 10.24 When the positive and negative wire inputs to one of the stereo speakers have been
interchanged, the speakers are then out of phase. The collision would have been massively spectacular, spewing debris everywhere while turning Earth fully molten. The image is as far behind the mirror as the object is in front of the mirror, and image and object have the same size—as long as the mirror is flat. Much that we know about Earth's
interior was learned as a result of the Cold War between the United States and the former Soviet Union. Because light refract by different amounts. Step 1. T 151 LEARNING OBJECTIVE Describe the direction of flow of ordered energy to disordered
energy in nature. How much force does it exert? Now hold the two bills in front of your eyes. The hydraulic arrangement works to his disadvantage. These systems on Earth. So, carrying our analogy with buildings further, different architecture using
the same materials can result in very different minerals. Work = QKE Work equals change in kinetic energy. For the planet half as far from the Sun, light B S-5 1 would be 4 times as intense. Why is the support force on an object often called the normal force? Think of the rug example. The colors magenta, cyan, and yellow are the subtractive primary
colors. 18 PARTONEPHYSICS FIGURE 1.7 Why will a slow continuous increase in downward force breaks the lower string? Within a few years, the atoms of your breath are uniformly mixed throughout the atmosphere. (Ignore friction.) DA6 m/s D6 m/s BC
18 m/s 70. Hydrogen chloride and sodium hydroxide (base) + Sodium chloride (acid) NaOH h NaCl Sodium hydroxide (base) + Sodium chloride and water: HCl + Hydrogen chloride and water: HCl + Hydrogen chloride (acid) NaOH h NaCl Sodium hydroxide (base) + Sodium chloride and water: HCl + Hydrogen chloride and water: HCl + Hydrogen chloride (base) + Sodium chloride (base) + 
HCl Hydrogen chloride (acid) FIGURE 18.5 "Salt-free" table salt substitutes contain potassium chloride. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) Each chapter in this book concludes with a set of questions and exercises, and for some chapters there are problems. Also, no carcinogenic by-products
result from treating wastewater effluent with ozone. Erosion The wearing away of rocks, and the processes by which rock particles are transported by water, wind, or ice. The amount of energy needed to change a unit mass of any substance from solid to liquid (and vice versa) is called the heat of fusion for the substance. No! What it means is that the
diver no longer gains speed. But we have seen that the instantaneous velocity at the end of the first second is 2 m/s. This deflection of starlight can be observed during an eclipse of the Sun. If the cannonball would circle Earth indefinitely. Carbonates
are minerals and rocks composed mostly of calcium carbonate, CaCO3, which has the mineral name calcite. These regions are the asteroid belt, the Kuiper belt, and the Oort cloud. Oxidation occurs at the anode (remember "an ox" pulls the "red cat" in a cart). Is it possible for him to give either of the cars a greater speed than the other? How readily
an acid donates a hydrogen ion is a function of how well the acid can accommodate the resulting negative charge it gains after donating the hydrogen ion. This is similar to the constant ratio of circumference to diameter for circles, which equals the constant p. Without updrafts, the droplets drift so slowly out of the bottom of the cloud and evaporate
so quickly that they have no chance of reaching the ground. Your balloon is negatively charged because it picks up electrons from your hair. 15, 2014 Oct. a, b, c, d. a = = = 5.0 m/s2. If you stand next to a wall and jump up so that your feet are no longer in contact with the floor, does the moving wall slam into you? Is your friend's claim likely
correct or nonsense? 478 PA R T T W O CH E M I S T RY LEARNING OBJECTIVE Provide examples of electrolysis as an application of oxidation- reduction reactions. Hence the bag remains at rest. This, in turn, promotes the chemical reactions. Hence the bag remains at rest. This, in turn, promotes the chemical reactions.
built largest telescope in the world at Mt. Wilson in California, Hubble made out individual stars within the Andromeda spiral nebula (Figure 27.22). The open structure of these crystals increases the volume of the water slightly. Red to brown shale contains ferric oxide (red) or ferric hydroxide (brown). A rainbow is the result of light in raindrops that
undergoes (a) internal reflection. We often marvel at a new technology, but how long does this marveling last? Why does a hot frying pan cool faster than equally hot water? An incandescent lightbulb with an operating resistance of 95 \( \frac{1}{3} \) is labeled "150 W." Is this bulb designed for use in a 120-V circuit or a 220-V circuit? FIGURE 7.1 0 Types of
radiant energy (electromagnetic waves). Germanium, Ge (atomic number 32), computer chips operate faster than silicon, Si (atomic number 14), computer chips operate faster than silicon, Si (atomic number 120 V across this lowered resistance may produce a harmful current in your body. We say the truck has more
momentum than the car. The answer is: from some self-sustaining exothermic reaction occurring elsewhere. What factors are responsible for condensation? 230 PARTONEPHYSICS FIGURE 9.33 This common transformer lowers 120 V to 6 V or 9 V. What is the difference between a rock and a mineral? If you have ever collected rocks and
minerals, you probably have some quartz and feldspar specimens in your collection. Both crystallization and partial melting act to increase the magma's silica content. Distillation and reverse osmosis, therefore, are also used to purify naturally occurring fresh water. So although a vocabulary of science terms is useful for communication, it does not
guarantee conceptual understanding. LEARNING OBJECTIVE Compare and contrast asteroids, Kuiper belt objects, and the Oort cloud. Therefore the molar mass is 18 g/mole. First convert the 300,000 mi to light-years: CHECKPOINT Which is greater: the number of galaxies in the observable universe? 254 PA R T
ONEPHYSICS FIGURE 10.36 Pressure The shock wave of a bullet piercing a sheet of Plexiglas. If the air is humid, clouds form. The resulting basin, where suspended solids settle out as sludge (Figure 16.37). * The term deposition in
meteorology refers to the conversion of water vapor to a solid. Some exothermic reactions are so exothermic that they explode if not run at cold temperature play in the direction of thermal energy flow? Former student Cassy Cosme safely breaks bricks with her bare hand on page 65.
The fact that the desk is at rest is evidence that \triangle F = 0. READINGCHECKQUESTIONS (COMPREHENSION) 8.1 Electric Charge 1. The LMC is dotted with hot young stars with a combined mass of about 2 billion solar masses (Figure 27.29). The next day
they are both reopened, and one is less fizzy. (b) A hydroxide ion and a water molecule are the same things. Consider the case of your hand pushing on the wall. They have crushed themselves out of visible existence. Archimedes' principle An immersed body is buoyed up by a force equal to the weight of the fluid it displaces (for both liquids and
gases). As you swim deeper, more water is above you. Now balance the book on the palm of your hand and you sense a difference—the pressure of the book depends on the area over which the force is distributed (Figure 5.2). Aristotle used logic to establish his ideas of motion, whereas Galileo used experiment. but it is there. 7 Electrolysis 18. Place a
card over the open top of a glass filled to the brim with water, and then invert the glass. Oxygen atoms are used to make water molecules. Oxygen atoms and reacts with them to form water, H2O, as Figure 15.18 shows. Above the curve, the
condensation rate is greater than the evaporation rate, and precipitation forms. (a) Write an equation for the car's average speed when it travels a complete lap in time t. These frequencies are forbidden because their wavelengths are not a multiple of the length of the tube. Which is an example of a chemical change? Each hydrogen-oxygen covalent
bond has a relatively large dipole because of the great electronegativity difference. (a) A = B = C. The worth of a model lies not in whether it is "true" but in whether it is "true" but in whether it is useful—in explaining observations and predicting new ones. Stoichiometry is an of oxygen (O2, 32 amu) in the reaction area of chemistry rich in opportunities below? Balls of mass
m1 and m2 attract each other with a force F equal to the weights needed to restore balance. Each domain is perfectly magnetized and is made up of billions of aligned atoms. Cross-cutting relationships Where an igneous intrusion or fault cuts through other rocks, the intrusion or fault is younger than the rock it cuts. For both electricity and heat, the
conduction is via electrons, which in a metal are loosely bound, easy flowing, and easy to get moving. The mass of one golf ball is 40 g. What would be its mass on the Moon and on Earth? Galaxies are not simply coasting away from each other and slowing down. Pascal's principle was discovered in the 17th century by theologian and scientist Blaise
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Pascal, for whom the SI unit of pressure, the pascal (1 Pa = 1 N/m2), is named. Galileo reasoned that the total distance fallen should be proportional to the square of the time. * I am indebted to Burl Grey for the stimulation he provided, for when I continued with formal education, it was with enthusiasm. This fusion power project is the International
Thermonuclear Experimental Reactor (ITER). If fusion power were harnessed today, the abundant energy resulting would probably sustain and even further encourage our present appetite for continued growth and in a relatively few doubling times produce an appreciable fraction of the solar power input to the earth. Chlorine atoms lower the energy
barrier of this reaction by providing an alternate pathway involving intermediate reactions, each having a lower activation energy than the uncatalyzed reaction. And the one layer of Earth that is liquid is composed of molten iron, not magma, and is not encountered until a depth of almost 3000 km. If the world's highest mountain, Mt. Everest, were
sunk to the bottom of the Marianas Trench, there would still be more than a mile of ocean above it! Subduction is an important part of mantle convection. We say it's in dynamic equilibrium. Water flowing between the ships travels faster than water flowing past the outer sides. Try to blow the card from the spool by blowing through the hole. For
Russell to publicly change his mind about his ideas is a sign of strength rather than weakness. Show that when the distance traveled is one wavelength l and the time of travel is the period T (which equals 1/frequency), you get v = f l. Consider the possibilities: wall paint that can change color or be used to display video; smart dust that the military
could use to seek out and destroy an enemy; solar cells that capture sunlight so efficiently that they render fossil fuels obsolete; robots with so much processing power that we begin to wonder whether they experience consciousness; nanobots that roam our circulatory systems destroying cancerous tumors or arterial plaque; nanomachines that can
 "photocopy" three-dimensional objects, including living organisms; medicines that more than double the average human life span. 25.3 Cloud Development 17. How can this be? (a) How much time does it take for the ball to reach the top of its trajectory? Why, then, does the cannonball undergo more acceleration than the cannon? 18.5 Losing and
Gaining Electrons 15. FIGURE 26.20 Neptune Neptune has a diameter about 3.9 times that of Earth, a mass 17 times as great, and a mean density about a third of Earth's. The answer is that this ghostly form of matter gives itself away by its gravitational effects. As a matter of fact, that's where the helium in a child's balloon comes from—practically
all of Earth's helium atoms were at one time energetic alpha particles. In chemical weathering, the stream water contains dissolved substances that react with rock material. Minerals that contain both silicon (Si) and oxygen (O) as part of their chemical composition are called silicates. This reaction generates a hydroxide ion, which increases the pH
of the solution. According to the heat death scenario, about how long will it take for the black holes of the universe to evaporate? If Earth were suddenly stopped in its tracks, it would promptly drown. (It is.) Can this air be
made fresh by passing it through a filter of activated charcoal? What's more, the atoms of which you and your friend are composed will be found in the bodies of all the people on Earth who are yet to be. Compare the pressure exerted by the tires of your car on the road with the air pressure in the tires. Nitrogen is easier to handle than liquid helium,
which is needed for creating colder conditions. Electrical devices connected to the same two points of an electrical circuit are said to be connected in parallel. Water molecules are so small that an 8-oz glass of water contains about a trillion trillion of them. The more massive a planet, the greater the weight of material pushing downward, which
increases the internal pressure. This helium is isolated and sold for various applications, such as blimps and helium balloons. As the magnetic field strength inside the coil is increased (as the magnet enters), the induced voltage in the coil is directed one way. So unless you become familiar with the physics to follow in this book, Aristotle's views about
motion do make common sense (and are held by many uneducated people today). Consider the satellite moving clockwise in Figure B.11. What are two sources from which minerals crystallize? Type of Bond Number of Moles HiO 4 Bond Energy released in this
reaction exceeds the amount of energy absorbed. PROLOGUE REVIEW 11 R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 1. FIGURE 10.8 Our subjective impression about the frequency of sound is described as Compressions and rarefactions travel pitch. Neglecting air resistance, assume it takes 30 s for the engine to hit the ground.
Both travel at lower speeds than P- and S-waves and so register last on a seismograph. Furthermore, as acid rain continues to pour into these regions, the need to lime also continues to pour into these regions, the need to lime also continues. 64. When molten material is cooled so quickly that atoms do not have time to arrange into these regions, the need to lime also continues to pour into these regions, the need to lime also continues.
waves Radiant energy exists in the form of electromagnetic waves, ranging from the longest waves, microwaves, infrared waves (invisible waves, microwaves, microwa
and mist is attracted to it—presto— the car is quickly and uniformly painted. Air-conditioning units contain no water whatever, yet it is common to see water dripping from operating air conditioners poking outside homes on a hot day. As shown in Figure 13.31, these nuclei are lower on the graph than uranium, which means that they have a smaller
amount of mass per nucleon. The individual puffs are much larger than those in cirrocumulus clouds, and the color is also much darker. Because an element is defined by the number of protons in its nucleus, the 90 protons and 144 neutrons left behind are no longer identified as being uranium. Low-solubility minerals are difficult to dissolve; high-
solubility minerals are easier to dissolve. (b) dispersion. These devices do work to pull negative charges apart from positive ones. Likewise, a chemist would be at a loss in setting up a chemical reaction if she did not know the relative masses of the reactants. (Can you see that this is a simple extension of Figure 9.16?) Current In an advanced course
you'll learn the "simple" right-hand rule. Equal masses 17.2 Counting Atoms and Molecules by Mass EXPLAIN THIS How many molecules of carbon dioxide are there in 44 g of carbon dioxide? For example, as an air parcel flows up the side of a mountain, the pressure exerted on it decreases, allowing the air parcel to expand—and cool without any
heat exchange. (The nanometer is a common unit of length in atomic and optical physics.) 45. If your friend pushes a stroller four times as far as you do while exerting only half the force, which one of you does more work? A similar subset (atomic numbers 90 to 103) is found within the seventh period. Hewitt (top) Nancy Rogers/Paul G. As discussed
in Section 7.2, compression also increases the temperature, which further favors the chemical reaction. CHECKPOINT What must an electron be doing in order to have wave properties? Does it depend on the sign of the charges? Use the following illustration for Exercises 79-82. FYI The stored energy released in an earthquake does not come as a
single large guake. But the state of rest is only one form of equilibrium. Two point charges are separated by 4 cm. It is interesting how the focus of our speculations has been narrowing down over our history. With this broader perspective, the second law can be stated another way: In natural processes, high-quality energy tends to transform into
lowerquality energy—order tends to disorder. He was a modest man, very sensitive to criticism, and he never married. 36 55 92 143 56 86 1 0 n 235 92 U 91 36 Kr 142 56 Ba 3(10 n) Note in this reaction that 1 neutron starts the fission of a uranium nucleus and that the fission produces 3 neutrons. The center of the nebula becomes dense enough to
trap infrared radiation so that this energy is no longer radiated away. But there is gravity, so this doesn't occur. 29. The polar head in a detergent molecule, however, typically consists of either a sulfate group, - SO39, and the nonpolar tail can have an assortment of structures. It can increase the system's thermal
energy, or it can enable the system to do work on its surroundings (or both). Prevailing wind F I G U R E 2 5 .11 Rai sh a n A mountain range may produce a rain shadow on its leeward slope. In these locations, many people drink their water in the form of a hot beverage, such as tea, which is disinfected through boiling. If she holds her breath while
returning to the surface, what happens to the volume of her lungs? Tendency to gain electrons More likely to behave as reducing agent (be oxidized) Whether a reaction classifies as an oxidation-reduction reaction is not always immediately apparent. If you stand next to
a wall on a frictionless skateboard and push the wall with a force of 40 N, how hard does the wall push on you? The fact that we can see a ringing bell but can't hear it indicates that light is a distinctly different phenomenon than sound. The fact that we can see a ringing bell but can't hear it indicates that light is a distinctly different phenomenon than sound. The fact that we can see a ringing bell but can't hear it indicates that light is a distinctly different phenomenon than sound. The fact that we can see a ringing bell but can't hear it indicates that light is a distinctly different phenomenon than sound. The fact that we can see a ringing bell but can't hear it indicates that light is a distinctly different phenomenon than sound. The fact that we can see a ringing bell but can't hear it indicates that light is a distinct phenomenon than sound.
accomplished has to do with Fourier analysis, which concludes our study of sound. A rainbow viewed from an airplane may form a complete circle. A satellite can orbit at 5 km above the Moon's surface but not at 5 km above the Moon's surface but not at 5 km above the Moon's surface. The Crustal Surface The top part of the lithosphere is the crust. In this chapter we learn that the cause of
acceleration is given by Newton's second law: a = Fnet/m. 178 PA R T O N E P H Y S I CS F I G U R E 7. As energy is removed from a liquid, molecular motion slows until molecules move so slowly that attractive forces between them bind them together. A simple lever is used to lift a heavy load. The greater the voltage, the greater the current. The
placebo effect is very real and measurable via blood titrations. 1 C O M M O N P O LYAT O M I C I O N S Name Formula H3O + NH 4 + HCO 3- Hydronium ion Ammonium ion Bicarbonate ion CO 32- Sulfate ion SO 4 2- Phosphate ion PO 43- Similarly, the
 carbonic acid molecule, H2CO3, can lose two protons to form the carbonate ion, CO32-: O O C H O O Carbonic acid H -O C O- Carbonate ion 2 H Hydrogen ions (protons) How these reactions occur will be explored in later chapters. The outer planets are large, have many rings and satellites, and are composed primarily of hydrogen and helium gas
An electric toy draws 0.5 A from a 120-V outlet. In the Northern Hemisphere, as prevailing winds blow clockwise, pattern. Hold two toothpicks side by side and attach one jellybean to each end such that each jellybean has both toothpicks poked into
it. Because the volume of the solution is equal to the combined volume of the solution minus the volume of the vol
material called peat. Why does the Big Dipper change its position in the night sky over the course of the evening but Polaris, the North Star, remains relatively fixed in its position? Bubbles of hydrogen form on one wire, and bubbles of oxygen form on the other. A few examples are shown in Figure 12.4. Pure gold, for example, is an element—it
contains only gold atoms. F I G U R E 1 4 .1 Special materials of chemistry, such as rocket fuels, metals for spaceships, and fabrics for the space suits, were required to allow astronauts to reach and explore the surface of the Moon. When you pull up on the handlebars, the handlebars in turn pull down on you. Newton's second law provides the
explanation. Identify any chemical changes. • Each chapter review concludes with a set of 10 multiple-choice questions called the Readiness Assurance Test (RAT) that students can take for self-assessment. In this view, orientation of the domains is random. 229 FIGURE 9.30 Steam drives the turbine, which is connected to the armature of the
generator. Nevertheless, he completed his studies on motion, and his writings were smuggled out of Italy and published in Holland. The Mastering system helps instructors maximize class time with customizable, easy-to-assign, and automatically graded assessments that motivate students to learn outside of class and arrive prepared for lecture. The
Mercalli scale measures earthquake intensity. What is the best way to really prove to yourself that you understand an idea? G L O S S A RY Corrosion The deterioration of a metal, typically caused by atmospheric oxygen. Rank the magnitudes of these units of thermal energy from greatest to least: (a) 1 calorie, (b) 1 Calorie, (c) 1 joule. 218 PA R T O N
E P H Y S I CS LEARNING OBJECTIVE Relate magnetic field strength to magnetic field patterns. 300 m.y.a. With the improved technology of 300 m.y.a. The net force on the
desk is zero and it slides at an unchanging speed. Mercury is more dense (13.6 g/cm3) than iron. The environmental lapse rate describes the manner in which these temperature changes occur with altitude. Yes, an object can have energy without momentum if we consider PE (if an object has KE, then it must have momentum because it is moving). As
the maple syrup is boiled, the sugar within the syrup begins to caramelize, which is a chemical change. Intermediate frequencies. Newton "opened up" the universe, showing that the same natural laws that act on Earth govern the larger cosmos as well. Parallel lines would appear to remain parallel.
Any sufficiently advanced technology is indistinguishable from magic. A friction force f opposes this motion. We left off with a discussion on how superclusters of galaxies extend throughout the universe. What remains of the asteroid belt is small. There are 69.7 g of gallium, Ga (atomic mass 69.7 amu). Recall that temperature is average kinetic
energy per molecule, which means total energy is a lot only for lots of molecules. What Planck did with his quantum hypothesis was to recognize that a beam of light energy released when the bond is formed equals the amount of energy needed to break the
bond, which is 436 kJ. During an average six-day life, most of these ants retrieve 15 to 20 times their weight in food. As the carbon of propane, C3H8, forms carbon dioxide, CO2, it is losing hydrogen and gaining oxygen, so the carbon is being oxidized, which is the opposite of what happens to carbon during photosynthesis. A network of such strong
fibers could be used to build the once sciencefictional space elevator. Shell A region of space around the atomic nucleus within which electrons may reside. As discussed in Section 17.5, the energy from this reaction is used to power rockets into space. Octane molecules, like long strips of Velcro, are relatively difficult to pull apart because of the
larger number of induced dipole-induced dipole-induced dipole attractions. When the block is submerged in water, its loss in weight is the buoyant force, which equals the weight of water displaced. Identify this force, which equals the weight of water displaced. Identify this force, which equals the block is submerged in water, its loss in weight is the buoyant force, which equals the weight of water displaced. Identify this force, which equals the weight is the buoyant force. Shield volcanoes are built by a steady supply of easily flowing basaltic lava that flows out in all directions to make a broad, gently sloping cone. Why
can't you assume that box B represents a lower temperature? After World War I, Bayer, a German company, lost the rights to use the name aspirin. So 11 millionths of 6370 km = 70 m. The direction of the light waves changes when one part of the wave slows down before the other part. Two opposite processes occur for the water at the same time—
contraction and expansion. Covalent bond A chemical bond in which atoms are held together by their mutual attraction for two or more electrons they share. Show that the resistance of a circuit carrying current I and driven by voltage V is given by the equation R = V/I. Krypton, Kr, for example, has 18 electrons in its valence shell, but only 8 of these
are classified as valence electrons. To be a crystalline solid means that the atoms that make up a mineral are always arranged in an orderly geometric pattern. The minerals muscovite (mica) and calcite both have well-defined cleavage (Figure 20.8). Paleozoic—trilobites, shelled animals, first fishes, first amphibians, first reptiles;
major extinctions in the Ordovician and Permian. When momentum, or any quantity in physics, does not change, we say it is conserved. The coal industry far outranks the nuclear power industry as a source of radiation, by moisture condensation, or by contact with warm ground. 3
General Relativity 28. LEARNING OBJECTIVE Relate learning science to an increased appreciation of nature. 346 PA R T T W O CH E M I S T RY 63. Concepts from physics are reexamined in the driving forces of weather. How is an airplane able to fly upside down? For this reason, isotopes of an element share many characteristics—in fact, as
chemicals they cannot be distinguished from one another. The wall simultaneously exerts an equal and opposite force on you. These internal movements generate waves that travel through Earth's surface—seismic waves. But gravity diminishes with distance by the inverse-square law. The atom or molecule in turn then
emits, with some time delay, a new "bullet of light" in the same direction. Can a machine multiply the input force? The speed of sound in dry air at 0°C is about 330 m/s, which is nearly 1200 km/s. The Sun will spend most of its lifetime—some 10 billion years—on the main sequence, with thermal pressure keeping gravity at bay. Satellites remain in
orbit because they are being pulled by gravity, not because they are beyond it. Unlike carboxylic acids, esters are not acidic because they have sause the material through which they travel to oscillate up and down and from side to side. Now in his
90s, he continues to inspire people toward a positive future through his books, TV documentaries, and most recently by the movie that features his vision, "Future By Design." CHAPTER 1 1.5 PAT T E R N S O F M OT I O N A N D E Q U I L I B R I U M The Equilibrium Rule EXPLAIN THIS How can the sum of real forces result in no force at all? 2
Convection 7. As the topography of the ocean floor was revealed in the Atlantic Ocean basin, a different kind of mapping was being done in the Pacific basin—the intensity of Earth's magnetic field. The number of atoms that are bonded to each of the two middle carbons of 2-butene is bonded
to only three other atoms—a hydrogen and two carbons. Asteroid fragments CHAP TER 26 known as meteoroids frequently find their way to Earth, where they are heated white-hot by friction with the atmosphere. Sulfuric acid is used to make fertilizers, detergents, paint dyes, plastics, pharmaceuticals, and storage batteries, as well as to produce iron
and steel. The polar heads of the soap molecules are attracted by ion-dipole attractions to water molecules, which then carry the soap-grime combination away. As such, they provide a record of climate change. The more basic 10 -11 11 a solution is, the lower its hydronium-ion 10-12 12 Hair remover concentration and the higher its pH. They have
also learned that the bigger the tree, the more it grows and hence the more carbon it sequesters. The book simply pushes the paper with it as it falls. 2.0 m/s 8.5 m/s 9.0 m/s 12.0 m/s 8.5 m/s 9.0 m/s 12.0 m/s 
wave that travels through Earth's interior. All these modes of motion, plus potential energy, contribute to the overall energy of a substance. At the contact, where temperature is high, water content is low because it has boiled away. One newton of input produces 50 N of output. Graphite is made up solely of carbon atoms. If two balls are lifted and
released, momentum is conserved as two balls pop out the other side with the same speed as the released balls at impact. When it is lifted above the surface, however, the force required to lift it is considerably more. Do you see how easy it is to explain the disappearance of the alcohol by supposing the existence of alcohol molecules? As the probe
gets closer still, the clock runs even slower. A block and tackle is a system of pulley can. The radiation emitted by Earth is in the form of infrared waves—below our threshold of sight. We start with static electricity, electricity at rest, and complete the chapter with current electricity. In the decentralized
 model, electricity is generated by numerous smaller substations, which may include personal wind turbines or photovoltaics. An amino acid is an organic molecule that contains both an amine group and a carboxyl group. Which has the higher specific heat capacity? But electrons are very small. So we see that neutrons are stabilizing and large nuclei
require an abundance of them. In a similar fashion, larger atoms can form temporary dipoles much more easily than smaller atoms, as is illustrated in Figure 15.40. The lifting LEARNING OBJECTIVE Describe the different types of clouds, and explain how they form. (Hint: Would the reading differ if one of the ropes were tied to the wall instead of to
the hanging 100-N weight?) 81. What is the acceleration of the jet? 17.4 Catalysts Chew a salt-free soda cracker for a few minutes and the cracker begins to taste sweet. (a) (c) (b) C H A P T E R 12 ATO M S A N D T H E P E R I O D I C TA B L E 307 (b) (a) FIGURE 12.20 in Figure 12.20b. This page intentionally left blank Glossary Ablation The amount
of ice lost, and the process of losing ice, from a glacier. Amplitude For a wave or vibration, the maximum displacement on either side of the equilibrium (midpoint) position. REVIEW 291 85. With this information, show that the speed of sound is 340 m/s. 3m 5m (a) (b) (c) CHAPTER 3 MOMENTUM AN D ENERGY 73 that the potential energy of the
elevated ball does not depend on the path taken to get it there. Our Sun is along the middle of the main sequence. Conversely, if Earth became hotter and hotter, more water would evaporate. The force approaches zero, but it FIGURE 4.6 never gets there. The newer, warmer ocean crust "rides" higher, forcing seawater onto the continents. What gas
(PVC), which is tough and easily molded. Wegener also looked at the fossil record. How is this different in science? Its density is small enough that the combined weight of the helium, the balloon, and the cargo is less than the weight of air they displace. D C 2m M d 2m M 2d 57. Also recall that transparency occurs for light of frequencies near (but
not at) the resonant frequencies of the material. The Sun does not have sufficient mass to supernova or to become a black hole. To the east? The same amount of force, in accord with Newton's third law—basic mechanics! Recall that a force is an interaction between two things—in this case, between the proton and the electron. These clusters of
aligned iron atoms are called magnetic domains. Also, don't use a cell phone when fueling. New rock is made from old. Today, worldwide production of aluminum is about 16 million tons annually. The volcanoes then begin erupting andesitic magma, which allows them to grow significantly higher. The electric force, however, does not diminish by
much across the diameter of a large nucleus and so begins to win out over the strong nuclear force. Share with him your calculations that show the volume of the balloon should be about 17 m3 (slightly more than 3 m in diameter for a spherical balloon). Two cars are raised to the same elevation on servicestation lifts. LEARNING OBJECTIVE
Distinguish between the processes of melting and freezing. Recall that 10a * 10b = 10(a + b). What is the second most abundant element? A fracture that is smooth and curved, so that it resembles broken glass, is called conchoidal. First measure the number of stacked pennies in 1 cm. Notice in Figure 5.12 that the 3-kg block has an apparent weight
 equal to the weight of 1 kg when submerged. ** In your education it is not enough to be aware that other people may try to fool you; it is more important to be aware of your own tendency to fool yourself. In both cases, heat at the hot end travels along the entire length. Water has the higher specific heat capacity. (c) The application of external
pressure forces water molecules to pass from the salt water to the fresh water, so that now the salt-to-fresh rate exceeds the fresh-to-salt rate. Just as a feather reaches terminal speed very quickly, the lighter person reaches terminal speed first. More specifically, the force with which a body presses against a supporting surface. Halite has an
 isometric crystal structure (three axes of equal length that make right angles) and a cubic form. CHECKPOINT Star A is four times as bright as star B, yet the two stars have the same luminosity. High Clouds Montana is called "Big Sky Country" because of the high lifting condensation level. These carbons are thus said to be unsaturated. (The unit
m.y.a. stands for "millions of years ago.") The lower red line is derived from evidence collected in Europe, and the upper red line is derived from evidence collected in North America. See Electric current Currents convection, 559 oceanic, 672–676 Cut banks, 606 D Darcy's law, 596 Dark energy, 97, 783–785 Dark matter, 97, 781–782 Deceleration, 28
Deep-water currents, 676 Deltas, 607-608 Density, 120 air, 686-688 mineral, 527-528 Deposition, 540-541 Depositional environments, 605 Depositional landforms, 613-614 Desalination, 416-417 Destructive interference, 248-249 Detergents, 410 in hard water, 411-413 Devonian period, 632-633 Diffuse reflection, 271 Dipoles, 380, 386-390
 induced, 387-390 Direct current, 198 Disconformities, in rock record, 624 Dispersion, 282-284 Dissolving, 403 Distillation, 398-399 Divergent plate boundaries, 602-603 Drainage systems, 599-603 Drift, 613 Dry-cell batteries, 473-474 Dunes, 615
volcanic ash, this mixture can expand and destroy everything in its path. Is this good news or bad news for a home in which much of the plumbing consists of iron and copper pipes connected together? 414 PA R T T W O CH E M I S T RY FIGURE 16.28 Volatile impurities are removed from drinking water by cascading it through the columns of air
 within each of these stacks. Do the readings indicate equal or unequal distances of fall for successive seconds? (b) Unlike charges attract. A few years later, Einstein recognized that these quanta of light behave much like tiny particles of matter. 72 PARTONE PHYSICS
object with your bare hands? b, c, d, a. A safety fuse. Only production rates for renewable resources, such as agriculture or forest products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such products, can be maintained at steady levels for long periods of time (Figure C.5), provided such periods of time (Figure
change from cold to warm. Pitch is how high or low we perceive a sound to be, depending fork through the air in the tube. The proton and electron have the same quantity of charge, but the opposite sign. And despite being a naturally occurring crystalline solid with a very ordered internal arrangement of atoms, table sugar (C12H22O11) is not a
Most stars have masses not very different from that of the Sun. At the time of the new Moon, the night sky does not show the Moon. Action and during the week on either side of the new Moon, the night sky does not show the Moon. Action and during the week on either side of the new Moon, the night sky does not show the Moon. Action and reaction forces are equal in strength and opposite in direction. Much vegetation that receives acid rain doesn't survive. This nebula must also have had a strength and opposite in direction.
slight net rotation, possibly due to the rotation of the galaxy itself. FYI 702 PA R T T H R E E E A R T H S CI E N CE W E ATH E R M A P S The weather forecaster's primary tool is the weather map, or chart. So the ball's acceleration will be 10 m/s2 (even though its speed will be greater). Equatorial regions spin faster than regions at higher latitudes.
A half-filled bucket of water is on a spring scale. The pH of the rain decreases (becomes more acidic) with increasing atmospheric concentrations of carbon dioxide, as in Figure 18.17. A typical 12-V battery has a rating of 60 ampere-hours REVIEW 211 (60 A for 1 h, 30 A for 2 h, and so on). + KOH h KCl Potassium hydroxide (base) Potassium chloride
(salt) + H2 O Water Potassium chloride is the main ingredient in "salt-free" table salt, as noted in Figure 18.5. Salts are generally far less corrosive than the acids and bases from which they are formed. Others may feel a certain degree of laziness. 52. When does a gain result in a negative? LEARNING OBJECTIVE Describe the similarities between a
florist greenhouse and Earth's climate. Science and the arts have certain things in common. Insulation such as rock wool or fiberglass VIDEO: The Secret to Walking on Hot Coals VIDEO: Air is a Poor Conductor F I G U R E 7.1 The tile floor feels colder than the wooden floor, even though both are at the same temperature. When can you add heat to a
EXPLAIN THIS How does burning fossil fuels lower the pH of the ocean? In 1929, he announced Hubble's law, which states that the farther apart galaxies are, the faster they move. Mountain ranges are the result of plate convergence. Does the speed of a falling object in the absence of air resistance depend on its mass? There is much research
(pyrite) Shutterstock 529: (gold) Shutterstock 532: (limestone) Dorling Kindersley 533: (left) Harry Taylor/Dorling Kindersley 533: (sandstone) Dorling Kindersley 533: (sands
iStockphoto 534: (middle right) Shutterstock 534: (bottom right) Colin Keates/ Dorling Kindersley Media Library 537: (a) Paul Dix / PNI/Cascades Volcano Observatory, U.S. Geological Survey 537: (b) Cascades Volcano Observatory, U.S. Geological Survey 537: (c) W. Altostratus clouds are a stable, layered type of cloud that often covers the sky for
hundreds of kilometers. For any e battery, the anode is always negative (-), which indiZn2 \le 2e Oxidation Zn cates that electrons are streaming away from this locaFIGURE 18.24 tion. It can't get any colder. 37. The Life Cycles of Stars EXPLAIN THIS Why doesn't a neutron star emit beta particles? Our ear performs a sort of Fourier analysis
 automatically. If we use g for the acceleration of a freely falling object (negligible air resistance), the equations for falling objects starting from a rest position become v = gt \ d = 12 \ gt \ 2 \ Much of the difficulty in learning physics, like learning any discipline, has to do with learning the language—the many terms and definitions. Two identical transverse
 waves that are out of phase destroy each other when they are superimposed. Air compressor Reservoir FIGURE 5.32 Pascal's principle in a service station. Agree; in series, more resistances add to the circuit resistance. That's why a blanket of snow keeps the ground warm in winter. He attended the sessions in Parliament for two years and never gave
a speech. So twice the force exerted on twice the inertia produces the same acceleration as half the inertia. Waves carry energy, and larger-amplitude waves carry more energy than smaller-amplitude waves carry energy, and larger-amplitude waves carry more energy than smaller-amplitude waves.
itself formed. Which gives us the brightest meteor showers? * Quaoar has a moon; Eris is 30% wider than Pluto and also has a moon. This occurs when sodium and chlorine are combined. There are 10,000 cm2 in 1 m2, so a column of air 1 m2 in cross-section that extends up through the atmosphere has a mass of about FIGURE 5.21 Is the piston
pulled up or pushed up? And the weight of this volume of water (not the submerged object!) is equal to the buoyant force. n a general sense, anything that moves back and forth, to and fro, from side to side, in and out, or up and down is vibrating. When light strikes glass perpendicularly, about 4% of the light is reflected at each surface
400 N 400 N 500 N 44. This is because it acts to destroy the digestive proteins and other important biomolecules in your stomach. VIDEO: Flotation A floating object displaces a weight of fluid equal to its own weight. What is the relationship between the maximum number of electrons each shell can hold and the number of elements in each period of
the periodic table? They play an important role as time indicators and in matching rocks from different places of similar age. Mineral A naturally formed, inorganic, crystalline solid composed of an ordered arrangement of atoms with a specific chemical composition. Modify the equation F©t = ©(mv) to show that the force of friction is 15 N. An
ampere is the rate of flow of 1 coulomb of charge per second. The result is mutual repulsion—levitation. Hunting at night, owls tune in to the soft rustles and Radioactivity T he atomic nucleus and nucleus and nucleur 13. Their movement causes earthquakes,
volcanic activity, and the deformation of large masses of rock that create mountains. (Rusting occurs only where iron behaves as an anode.) Ocean tankers, for example, are protected from corrosion by strips of zinc affixed to their hulls, as shown in Figure 18.34. Unlike others in his time, he did not wear a wig. So we must first define acceleration and
then define the terms that produce acceleration. In this book, however, we'll favor the single concept of frequency in describing light. Acetaldehyde: aldehyde. A mineral is a naturally formed, inorganic, crystalline solid, composed of an ordered arrangement of atoms with a specific chemical composition. 10 -8 8 Basic solutions have pH values greater
10 -9 9 Baking soda than 7. Then later in this chapter, we explore how the behavior of ions and molecules gives rise to macroscopic phenomena, such as the mixing of salt and water. As we shall soon see, the neutron becomes a proton once it loses the electron that is a beta particle. No, because an apple at the top of the twice-as-tall apple tree is not
twice as far from Earth's center. Any object that has a mass that is less than the mass of an equal volume of air rises in the air. Higher temperatures may significantly alter global weather patterns as well as raise the average sea level, as the polar ice caps melt and the volume of seawater increases because of thermal expansion. Consider a bar 1 m
long that expands 0.6 cm when heated. Bands of cumulonimbus clouds spiral around the low-pressure eye of the storm. Interestingly, any transition between two orbits is always instantaneous. G-6 G L O S S A RY Ion An atom having a net electric charge because of either a loss or gain of electrons. Box C is a mixture of the compound and the element
These changes in volume, in turn, allow for a buildup in pressure, called osmotic Fresh water Solution pressure. Can you see that a car has three controls that change velocity—the gas pedal (accelerator), the brakes, and the steering wheel? What will be your total wages for the month? Twice the energy divided by twice the charge gives the same
potential as one unit of energy divided by one unit of charge. On the other hand, in rocks such as basalt, shale, or slate, individual grains are difficult to distinguish—they are too small to be seen with the unaided eye. If you rub a glass or plastic rod with silk, you'll find that the rod becomes positively charged. They leave the surface and escape into
the space above the liquid. Why does the dough rise faster in a warmer area? Since the + and - terminals of the battery do not alternate either. Such a model shows how the various components of the system—humidity, atmospheric pressure, temperature, electric charge, the motion of large
masses of air—interact with one another. Hydronium ion A polyatomic ion made by adding a proton (hydrogen ion) to a water molecule. (b) seething with energy. Well, relax. Remember—induced dipoles are only temporary. Tim Gardner plays with air pressure on page 136 and induction on page 235. The minerals in rocks are naturally occurring,
inorganic, crystalline solids, with a specific chemical composition. WINDTKFFIGUREB.15WINDKTFFIGUREB.16WINDKFTFIGUREB.16WINDK
The Structure of Space and Time I n the preceding two astronomy chap- 28. Try doing this for at least 10 minutes. Nellie Newton hangs at rest from the ends of the rope as shown. Granite, composed of predominantly quartz and feldspar minerals, is resistant to chemical weathering. Simulate your own sunset: Add a few drops of milk to a glass of
water and look at a lightbulb through the glass. Chemical batteries don't FYI respond well to sudden surges of charge. Pick a star or constellation that lines up with a stationary landmark such as a tree or house. How deep must the glass be pushed in order to compress the enclosed air to half its volume? For comparison, gold has a density of about 19
g/cm3, while the average density of Earth is about 5.4 g/cm3. These are not dreams. As water droplets in the cloud bump into and rub against one another, the cloud becomes electrically charged. No star lasts forever. (c) both of these (d) neither of these 10. This is a great way to keep tabs on your water-conservation efforts. Look at the Mid-Atlantic
Ridge in Figure 21.27 and notice C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R how it is broken up into segments. Large, out-of-place boulders provide proof of a glacier's ability to transport heavy loads for great distances. The space between the stars of our galaxy contains about 2 hydrogen atoms per liter. With
respect to the silica content of the parent rock, what type of magma does partial melting produce? In old-growth redwood forests, some trees have survived for well over a thousand years. If the warmer air is moist and unstable, heavy rainfall and gusty winds develop. We now know that alkaline ashes contain compounds of group 1 elements, most and unstable, heavy rainfall and gusty winds develop. We now know that alkaline ashes contain compounds of group 1 elements, most and unstable, heavy rainfall and gusty winds develop. We now know that alkaline ashes contain compounds of group 1 elements, most and unstable, heavy rainfall and gusty winds develop. We now know that alkaline ashes contain compounds of group 1 elements, most and unstable, heavy rainfall and gusty winds develop.
notably potassium carbonate, also known as potash. (b) When the pressure on the salt side becomes high enough, equal numbers of water molecules pass in both directions. Many of the important ore deposits we find today were formed by the precipitation of
mineral constituents from water solutions. A bathroom scale measures weight, the force that compresses an internal spring or equivalent. (You can win bets on this question!) 75. These problems are assignable within Mastering using an internal spring or equivalent.
Conservation of energy for machines The work output of any machine cannot exceed the work input. To see this, suppose the ice cube is a 5-g cube; then while floating it displaces 5 g of water. In granite, the date signifies the age of the granite (when the mineral crystallized from magma). Consider that the charge of sodium's nucleus is 11 + . As long
as you and the jet are moving uniformly, catching the ball will be as easy as when the jet is parked at the gate. If the net force acting on an object is doubled, the object's acceleration will be doubled. 11:59 A.M.; the bacteria will double in number every minute! It is startling to note that at 2 minutes before noon the bottle was only 1/4 full. A dull finish
emits/absorbs better in the infrared than a polished one, whatever its color. If the door is an insulator, the balloon induces polarization of the molecules in the door material. As Earth grew, gravitational attraction Earth processes do not occur in isolation—events in one sphere affect one or both of the other spheres. How can you be both at rest and
moving at 100,000 km/h at the same time? (a) If the exponential rate of consumption for a nonrenewable resource continues until it is depleted, consumption falls abruptly to zero. At a particular speed, the difference in air pressure below and above the wings is 4% of atmospheric pressure. Sometime this well water smells bad because of trace
quantities of the gaseous compound hydrogen sulfide, H2S. LEARNING OBJECTIVE Identify compressions and rarefactions in a sound wave. Fill a U-tube with water and place pistons at each end, as shown in Figure 5.30. The auto in the sketch moves forward as the brakes are applied. Show that, when similarly heated, a 100-m bar of the same
material becomes 100.6 m long. How many electrons can occupy the first shell? This weight produces a pressure of 100,000 N/m2—or equivalently, 100,000 pascals (kPa). These are Mercury, Venus, Earth, and Mars. The nitrogen and oxygen molecules that make up most of the atmosphere are like tiny bells that "ring" with
high frequencies when they are energized by sunlight. We can't "see" an atom because it is too small. LEARNING OBJECTIVE Review the general properties of carbonyl compounds. Recall that the electrons of the benzene ring can migrate around the ring. A block of ice at 0°C is dropped from a height that causes it to completely melt upon impact.
These cycles occur age after age. Discuss the two ways this component accounts for (a) acceleration of the ball and (b) work done on the ball to change its kinetic energy. 352 PA R T T W O CH E M I S T RY 14.3 LEARNING OBJECTIVE Describe how materials can be identified by their physical and chemical properties. A completely submerged objects
 always displaces its own (a) weight of fluid. No. The shell model is not a depiction of the "appearance of an atom." Rather, it is a conceptual model that allows us to account for observed behavior. Distinguish between the diurnal and intrinsic motions of celestial objects. The source is nitrogen and oxygen ions (atoms stripped of electrons). It's okay to
 learn a little now, and to entrust a lot that remains for some future time or perhaps to others who chose to specialize within this field. Phases are also often shown: (s) for solid, (l) for liquid, and (g) for gas. Unstable air favors upward movement. CHAPTER 20 R O CK S A N D M I N E R A L S 521 F I G U R E 2 0 .1 la n i c R i d g e t Eurasian Plate
North American Plate -A t Mi d Juan de Fuca Plate Eurasian Plate E
boundaries, the strongest earthquakes occur along convergent plate boundaries where subduction occurs. We see nature differently when we know its rules. This indicates that Betelgeuse is a very luminous star emitting about 38,000 times as much energy each second into space as the Sun. Oxygen, O2 Reactants Water, H2O -486 kJ/mole Products
Reaction progress F I G U R E 1 7.1 9 A space shuttle uses exothermic chemical reactions to lift off from Earth's surface. The only waves that an electron exhibits while confined to an atom are those that are self-reinforcing. For Atomic symbol for nitrogen Atomic symbol for gold FIGURE 12. Thousands of neutrinos are flying through you every second
of every day, because the universe is filled with them. Ice, dihydrogen oxide, is a compound in pure form and a mixture when made from impure tap water. Although no nuclear fusion power in the near future. 123. These are
the two shown in the left box, one of which is also shown in the right box. Then direct a stream of water between them. The opposite holds true, too. A video game console requires 6 V to operate correctly. What is meant by saying that charge is conserved? Recall from Chapter 4 that perturbations in the planet Uranus led to the discovery in 1846 of a
farther planet, Neptune. Show that when they are separated by 8 cm the force between them is 5 N. The time required is (400,000 J/kg), (0.03 J/kg # yr) = 13.3 million years. The H-H single bond, for example, has a bond energy of 436 kJ/mole, but the H-O single bond has a bond energy of 464 kJ/mole. Compared to your weight on Earth, your weight
on Jupiter would be about (a) 3000 times as much. CHECKPOINT Which raises the temperature of water more: adding 4.19 J or 1 calorie? This is because all the water must be cooled to 4°C before lower temperatures can be reached. 15.5 Covalent Bonds 13. Hold the alpha emitter in your hand because the skin on your hand shields you. (b) a solar
eclipse. Earthquake The shaking or trembling of the ground that happens when rock under Earth's surface moves or breaks. 775: (right) Andrei Linde 776: NASA 783: NASA 784: NASA 783: NASA 784: NASA 785: (right) Andrei Linde 776: NASA 787: (right) Andrei Linde 776: (right) Andrei L
volume of air. Refraction The bending of an oblique ray of light when it passes from one transparent medium to another. We and all materials around us are mostly empty space. are two frequently used ways of showing a fluorine molecule without using spheres to represent the atoms: 2 F F F Remember—the straight line in both versions represent space.
two electrons, one from each atom. Show that the amount of heat generated in 1 min is about 60 kJ. It cannot be proven wrong, nor can it be proven right. If you double both the current and the voltage in a circuit, the power (a) remains unchanged if the resistance remains constant. See also Solar system and specific planets dwarf, 710, 729-730
inner, 709, 710, 714-718 orbits of, 96 outer, 709, 710, 718-719 physical properties of, 710 Plate tectonics, 555-588, 637-638 continental drift and, 567-568 earthquakes and, 577-581 faults and, 575-577 folds and, 574-575 seismic waves and, 556-557 subduction
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flotation, 125-126 Projectiles launched at an angle, 99-103 launched horizontally, 98 motion of, 97-104 satellites as, 104-108 trajectory of, 98-103 Proterozoic eon, 628 Protons, 297-299 in acid-base reactions, 455-458 mass of, 338-339, 341 strong nuclear force and, 326-328 Pseudoscience, 6, 190 Pulleys, 78-79 Pulsars, 750 Pure matter, 399-400 Q
Quality of sound, 255 Quantum, 310 Quantum hypothesis, 309-311 Quartzite, 548 Quasars, 759 I-6 INDEX R Rad, 324 Radiation, 168-171 cosmic background, 772-773 solar, 662-666 terrestrial, 169, 664 Radiation curves, of stars, 742-743 Radiation dosage, 324-326
Radioactive isotopes, half-life of, 328-331 Radioactivity, 322-326 Radioactivity, 322-326 Radioactivity, 322-333, 625-626 Rain, acid, 466-470 Rainbows, 282-283 Rarefaction, action and, 47-52 Reaction rates, 435-439 activation energy and, 438 Reactions, chemical. The intensity of light from a central
source varies inversely as the square of the distance. For example, the freezing and thawing of ice can widen preexisting cracks in rock. Oxygen is exactly what a fire needs to grow brighter and stronger. Light travels even slower in a silicon carbide crystal called carborundum. And every object has "energy of being"—stated in the celebrated equation
E = mc 2. Do this activity to see firsthand the destructive action of isopropyl alcohol on proteins. What kind of charge does an object acquire when electrons are stripped from it? Blue and yellow lights shining on performers, for example, produce the effect of white light—except where one of the two colors is absent, as in the shadows. An easy-to-read
pamphet describing the dos and don'ts about recycling can be effective. CHECKPOINT FYI What chemicals are produced as a nickel metal hydride battery recharges? Clouds are classified according to their altitude and shape. Cooling by radiation prevents Earth's temperature S-25 from rising indefinitely. Of physics, chemistry, and biology, which
science is the most complex? Then, from the conservation of momentum, with the same-mass freight car on the right after collision. If the alcohol were to donate the hydroxyl hydrogen, the result would be a negative charge on the oxygen. Wrap a piece of paper around a thick metal bar and place it in a flame. So block B has a mass of 20 kg. Yes,
friction acts to counter your push so the net force on the furniture is zero. Our current problem, however, is trying to figure out exactly what dark matter is made of. When a current problem the coils, forces on the wires rotate the coils. Hydrogen atom 1 \le Cl \ge 6 H2O H donor (acid) 1 \le Cl \ge 6 H2O H donor (acid
donates a hydrogen ion to one of the nonbonding electron pairs on a water molecule, resulting in a third hydrogen bonded to the oxygen. Creating these products, however, necessarily requires the input of energy, which we must obtain from some external source, such as electricity from a power plant that burns fossil or nuclear fuels. Technology is
our tool. Don't be surprised if it's heavier than your kid sister. Newton died at age 85 and was buried in Westminster Abbey along with England's kings and heroes. Hydrogen is the element whose atoms have only one electron. Low clouds (below 2000 m) Cirrus Stratus Cirrostratus Stratus Cirrostratus Stratus Cirrostratus 2. In a few locations
chlorine and ozone gases have been replaced by strong ultraviolet lamps, which, like ozone, kill both bacteria and viruses but provide no long-term residual protection. Applied to chemistry, entropy helps us to answer a most fundamental question: If you take two materials and put them together, will they react to form new materials? What obstacles
—technological, social, environmental, and political—do you foresee for such an endeavor? How tall would a glass have to be before water began to run out? Constant direction is a straight line—the object's path doesn't curve. Warming of the liquid results. Gravity by itself causes mass movement. F I G U R E 1 0 .1 0 Waves of compressed and
rarefied air, generated by the vibrating cone of the loudspeaker, reproduce the sound of music. When water freezes, the water molecules arrange themselves into six-sided crystalline structures that have much open space. A short answer is that salt makes ice melt. Show that the force of the punch on the paper is only 1.50 N. Chemical sediments
created by organisms are called biochemical sediments. They are one-step substitutions, much less challenging than the Think and Solve problems that follow. No. During electrical pressure (voltage). Some fish that live
beneath the ice are able to do the same. What are (a) its frequency and (b) its period? And fossils in these rocks help us understand (a) Earth's geologic and biologic history. In 2002, the claim was tested by researchers at the Mayo Clinic in Jacksonville, Florida, who randomly assigned 305 participants to wear an ionized bracelet for 28 days and
 another 305 participants to wear a placebo bracelet for the same duration. These lone pairs push the hydrogen atoms together, which allows the highly electronegative oxygen atom to pull electrons toward itself. They move from one place to another, they rotate, and they vibrate to and fro. You'll also be able to see spectral lines in streetlights and
 fireworks. What kind of nuclear power is responsible for sunshine? The brightest star in the sky, Sirius, is about 8 light-years from Earth. How are amides and carboxylic acids related to each other? Crunch! The can is crushed by VIDEO: Condensation is a Warming Process atmospheric pressure! Why? Students in a lab measure the speed of a stee
ball launched horizontally from a tabletop to be v. Component f 🐟, on the other hand, has increased and B C is now fully merged to become f F f' F. When the heater is also operating, the total line current increases to 18 amperes to the heater is also operating, the total line current increases to 18 amperes to the heater is also operating.
magnetic poles are known, the position of the magnetic pole at the time of formation can be determined. Distinguish between a musical sound and noise. Using stoichiometry, a scientist can calculate the amounts of reactants or products in any chemical reaction. Is the period longer or shorter for orbits of higher altitude? It's the coldest you can hope a musical sound and noise.
to approach. The extra electric power used just heats the bulb, which is why incandescent bulbs are much hotter to touch than equally bright CFLs. 8.10 Electric power EXPLAIN THIS Why shouldn't you connect a 120-V hairdryer to 240 V? Our description of motion and force depends on our "point of view." We distinguish between speed and velocity
(Chapter 1). In periods of peak demand, power companies lower their voltage in order to save them power (and save you money)! To see the effect, consider a 1200-W toaster that draws 10 A when connected to 120 V. For example, pigments that produce the color red absorb the complementary color cyan. Simulate the lunar phases. At the top of a
mountain, your mass is the same as it is anywhere else, but your weight is slightly less than it is at sea level. A disadvantage of ozone, however, is that it provides no residual protection for the effluent once it is released. Crust Earth's outermost layer. Note that the "fulcrum" is at the left end rather than in the center (as is the case in Figure 3.30). The
shuttle "coasts" by its own inertia. But because of gravity, it isn't. Other objects of Pluto's size continue to be discovered position again until 2178. High-speed protons and electrons are cast outward from the corona to generate the
solar wind, which powers the aurora on Earth and produces the tails of comets. Only 32 g of this oxygen What mass of nitrogen monoxide would react with the nitrogen (N2, 28 amu) reacts with 32 g left over unreacted. If you walk at 2 m/s, how fast do you and
your image approach each other? Although energy is familiar to us, it is difficult to define, because it is not only a "thing" but also both a thing and a process—similar to being both a noun and a verb. 13.6 Mass-Energy Equivalence EXPLAIN THIS Why does it get easier to pull nucleons away from nuclei heavier than iron? (b) Ft = \( \mathbb{Q}(mv) \) (c) KE = 12
mv2 (d) Fd = 12 mv2 5. (The physics of transparency and opacity is discussed in Chapter 11.) Now to why that car gets so hot in bright sunlight: Compared with the car, the Sun's temperature is very high. In the early 20th century, Einstein proposed that light, like matter, is affected by gravity. Unfortunately, such a fall through the event horizon of
a regular-sized black hole would not be survivable. REVIEW 517 64. Kinetic Energy and Momentum and kinetic energy are properties of moving things, but they differ from each other. Mercury (Figure 26.8) is about 1.4 times larger than Earth's Moon and similar in appearance. 4 Energy and Work 3. Also notice that some coins
last for a long time while others decay right away. To achieve isostatic balance, the higher the crust, the deeper the roots. Slightly tilted wings that deflect oncoming air downward produce lift on an airplane. Correct your friend's erroneous answer. 282 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Relate different speeds of light in a medium to
dispersion. • A student study area with Interactive Figures, award-winning selfguided tutorials, flashcards, and videos. Iron is at the bottom of the energy valley and is the most stable nucleus. Nineteenth-century experiments found something quite amazing. FYI 220 PA R T O N E P H Y S I CS FIGURE 9.8 INTERACTIVE FIGURE Pieces of iron in
successive stages of magnetism. THINKANDSOLVE (MATHEMATICALAPPLICATION) 42. This statement can be expressed as Force and distance between their centers. As discussed in the text, hydrogen chloride is a
strong acid, which means nearly all of the hydrogen chloride molecules donate hydrogen ions to form hydronium ions. (c) more than 20,000 N. One astronomical unit (AU) is about 1.5 * 108 km (about 9.3 * 107 mi) or the distance from Earth to the Sun. 7 Generators and Alternating Current 9. No component of force is acting in the direction of satellite
motion to change its speed. Comparing transportation efficient is the human on a bicycle—far more efficient than train and car travel, and even that of fish and animals. The potential energy due to elevated positions is called gravitational potential energy. Even though the hydrogen bond is much weaker than any covalent or ionic
bond, the effects of hydrogen bonding can be very pronounced. An intriguing property of all waves is interference. 162 PARTONEPHYSICS 67. The input force multiplied by the distance moved by the dist
machine operating on the same principle as a mechanical lever. (c) A second hole is sunk to intercept the cavity. What is the prime difference between a battery and a fuel cell? You might believe that light can be only one or the other, and that you must choose between them. (d) is unaffected, but not always. Railroad cars are loosely coupled so that
there is a noticeable time delay from the time delay from the time the first car is moved until the last cars are moved from rest by the locomotive. What two forces act on the monkey? Interestingly, the petals of most yellow flowers, such as daffodils, reflect red and green as well as yellow. But most minerals fracture irregularly. From greatest to least, rank the energy
needed for these phase changes for equal amounts of H2O: (a) from ice to ice water, (b) from ice-water to boiling water to steam. What additional field surrounds it when it moves? 189 Conservation of charge is another of the conservation principles. To better understand that the table pushes up on the book, compare the
case of compressing a spring (Figure 1.13). The air in a deep mine is denser because there is a greater mass of air over a deep mine than at sea level. These molecules represent a new material, and so set B represents a chemical change.
The large shallow lake exerts only half the average pressure that the small deep pond exerts. As more lines are opened at a fast-food restaurant, the resistance to the motion of people trying to get served is reduced. We see that A and B are simply switched around. About 10 years later, Hubble announced that the universe was not stable, but very
dynamic and expanding. Its atmosphere is mainly hydrogen and helium, with some methane and ammonia, which makes Neptune bluer than Uranus (Figure 26.21). Organic chemistry The study of carbon-containing compounds. (The Moon does the same to Earth and gives us tides.) If its long axis doesn't line up with Earth's gravitational field, a
vegetables than a lighter knife that is equally sharp? VIDEO: Bowling Ball and Conservation of Energy VIDEO: Conservation of Energy EXPLAIN THIS What is the energy score before and after galaxies collide? Arriving at the lower surface of the
drop, each color is again partly reflected (not shown) and partly refracted back into the air. (c) more momentum but less kinetic energy. Carbon-14 dating The process of estimating the age of onceliving material by measuring the amount of radioactive carbon-14 dating The process of estimating the age of onceliving material by measuring the amount of radioactive carbon-14 dating The process of estimating the age of onceliving material by measuring the amount of radioactive carbon-14 dating The process of estimating the age of onceliving material by measuring the amount of radioactive carbon-14 dating The process of estimating the age of onceliving material by measuring the amount of radioactive carbon-14 dating The process of estimating the age of onceliving material by measuring the age of onceliving ma
overall, does ball A or ball B have the greater average speed? LEARNING OBJECTIVE Summarize and contrast Newton's three laws of motion. The energy of the current causes the bonds holding atoms together to break apart. Sodium metal, for example, consists of neutral sodium atoms. Because molecules move rapidly, this physical contact is
appropriately described as a collision. Bohr also realized that the opposite is true: when a high-potential-energy electron in an atom loses some of its energy, the electron moves closer to the nucleus and the energy lost from the electron moves closer to the nucleus and the energy lost from the electron in an atom loses some of its energy, the electron moves closer to the nucleus and the energy lost from the electron is emitted from the electron in an atom loses some of its energy.
answer many of our current questions. Rages (SETI Institute) 721: (bottom) John Suchocki/ Paul G. Consider an apple at the top of a tree that is pulled by Earth's gravity with a force of 1 N. If an automobile had a 100%-efficient engine, transferring all of the fuel's energy to work, would the engine be warm to your touch? How is foliation different
from sedimentary layering? 18.7 Electrolysis 24. Poorly sorted, angular particles of various shapes imply a short transportation distance. To the scientist, the colors of objects are not in the substances of the objects themselves or even in the light they emit or reflect. Medium-mass stars progress from main-sequence stars to red giants or supergiants,
then to white dwarfs. Under the proper conditions, metamorphic rock can melt and become magma, which eventually solidifies as igneous rock to complete the rock cycle (Figure 20.37). Rank from greatest to least (a) their orbital speeds and (b) their times to orbit Earth. 27.5 Black Holes What happens to a light beam bouncing between two upright
and perfectly parallel mirrors here on Earth? What dwarf planet was downgraded from planetary status in 2006? You have more electrons after you scuff your shoes, so you are negatively charged (and the rug is positively charged). Atomic chlorine is a catalyst for the destruction of ozone. A modified version of this equation was thus created to
account for the observed orbital velocities of stars within galaxies. His body still remains as part of the Greenland glacier. Which cloud form is associated with a stable air mass? Stainless steel is a mixture of iron and carbon. As more empty spacetime is created, the vacuum energy becomes more predominant, which accelerates the formation of even
more empty spacetime. When you lift your finger, the water spills out the bottom. More than 90% of Earth's minerals are silicates—composed predominantly of silicon and oxygen plus other elements such as aluminum, iron, calcium, sodium, potassium, and magnesium. If you build a fire on the beach, you'll see that the smoke sweeps inland during
the day and then seaward at night. Group A vertical column in the periodic table, also known as a family of elements. Atoms are so small that each breath you exhale contains more than 10 billion trillion of them. African Plate IndoAustralian Plate Pa fic Rise ci Pacific Plate Eas Nazca Plate South American Plate t Antarctic Plate 20.1 The Geosphere Is
Made Up of Rocks and Minerals EXPLAIN THIS Why are Earth's elements unevenly distributed? Answer: the gecko's foot is extremely nonpolar. Most materials are made from more than one kind of atom. At the same time, however, the oxygen atom on the opposite side of the carbon pulls those electrons back to the carbon. But momentum is
conserved even when the colliding objects become entangled during the collision. This happens primarily deep underground. 5 Energy and Chemical Reactions 17. Electrons close to one another in a cluster vibrate in phase. In this textbook, our focus is on conceptual atomic models that are easily represented by visual images, including the planetary
model and a model in which electrons are grouped in units called shells. We are standing on the solid geosphere and atmosphere are at work weathering the rock we stand on. Why are meteorites so much more easily found in Antarctica than in other continents? Because the apparent path of polar movement varied
from continent to continent, it was more reasonable that the continents had moved. The balls vibrate in rhythm with your vibrating paddle. Electrical resistance The property of a material that resists the flow of an electric current through it, measured in ohms (\( \)). 4 m/s A 6 m/s B 100 N 75 N 30 kg 20 kg 10 kg A B C 71. In answer to the question
 "When a plant grows, where does the material come from?" Aristotle hypothesized by logic that all material came from the soil. Does Bernoulli's principle refer to internal pressure changes in a fluid, or to pressures that a fluid can exert on objects in the path of the flowing fluid? With a single click, charts TVNNBSI[FUIFNPTUE]

### DVMU problems,
vulnerable students, grade distribution, and even improvement in scores over the course. The Exercises stress thinking rather than mere recall of information and flying squirrels are not alone in increasing their surface areas when falling. As you
would imagine, a wide area of rainy weather accompanies occluded fronts. How much transmits and how much reflects varies with the incident angle. Instead of visualizing gravitational forces between masses, we abandon altogether the notion of force and instead think of masses responding in their motion to the curvature or warping of the
spacetime they inhabit. A hockey puck slides across the ice at a constant velocity, Also interesting is that a current-carrying wire has almost no net charge. In this case, they indicate a coming storm, Neglecting air resistance, what happens to the horizontal component of its velocity along its trajectory? Hewitt 711: NASA, ESA, M. Well, if 1 mole of
water, H2O, equals 18 g (formula mass 18 amu), then 2 moles equals 36 g. You can build a relatively inefficient but fun-to-watch distiller at home. The three rays can be separated by placing a magnetic field across their paths (Figure 13.2). This change in frequency due to the motion of the source (or due to the motion of the receiver) is called the
Doppler effect (after the Austrian physicist and mathematician Christian Doppler, who lived from 1803 to 1853). There has to be more energy output. Convert the given mass to moles: Conversion factor 1 mole CH4 (16 g CH4) a b = 1 mole CH4 16 g CH4 Step 2. See Vehicles Catalysts, 439-441 Cathodes, 474 Caverns,
598-599 Caves, 598-599 Celestial sphere, 739 Cenozoic era, 637-641 Channel geometry, 600-602 Charged particles. Superconductors In common household wiring, flowing electrons collide with atomic nuclei in the wire and convert their kinetic energy to thermal energy in the wire. Reaction rate A measure of how guickly the concentration of
products in a chemical reaction increases or the concentration of reactants decreases. Did Aristotle believe that, once moving, they'd move of themselves? Topple the first domino and observe your chain reaction. f 6 * 1014 Hz This is 5000 times larger than the size of an atom, which
is about 0.1 nm. So although the cannonball in the preceding example gains momentum when fired and the recoiling cannon gains momentum in the opposite direction, there is no gain in the cannon-cannonball system. These forces cancel out, as far as any motion of the car is concerned. If we heat a pot of water on a stove, we might find that it
requires 15 minutes to rise from room temperature to its boiling temperature. The theory of plate tectonics states that Earth's outer shell, the lithosphere, is divided into eight relatively large plates and a number of smaller ones (Figure 21.20). But because the two speeds are so different, the plane you see appears ahead of the plane you hear. You're
closer to Earth's center at sea level, so you weigh more there than on any mountain peak. Atoms with low electrons easily and, therefore, also behave as strong reducing agents. At one extreme, corrections can be made and life will be fine for Earth's inhabitants. REVIEW 235 72. Good reflectors, on the other hand, are
poor absorbers. The fuel source may be the depleted uranium stockpiled from earlier reactors. If Earth didn't spin on its axis but still revolved around the Sun, would the Sun set on the eastern or western horizon or not at all? 5 3 (a) (c) (b) All transparent crystals having a noncubic natural shape have the property of polarizing light. (a) From greatest
to least, rank them by the force needed to keep them moving. In one pot, use warm water from the kitchen faucet. The colors of the above (e) none of the a
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ponent, and S is the sideways component, the force that moves the F D lawnmower forward. When released in a uniformly moving spaceship, the balls would continue to move with the spaceship at the moment of release. Rank the magma types in order of increasing (low to high) silica content: (a) basaltic, (b) granitic, (c) andesitic. In pre-Copernican
 times the Sun and Moon were viewed as planets. But the number of stars is insufficient to account for all the observed helium—not more than 10% of the observed helium—ould have originated in stars. 3 D R I V I N G F O R CE S O F W E AT H E R 693 CL ASSI F I CATI O N O F A I R MA S S E S A N D T H E I R CHARACTERI STI CS Typical Source
Region Classification Symbol Characteristics Arctic Greenland North Atlantic and Pacific Oceans Canada, Siberia Caribbean Sea, Gulf of Mexico, southwestern United States maritime arctic continental arctic maritime tropical cP mT
continental tropical cT cold, dry, stable warm, moist, usually unstable hot, dry, stable aloft, unstable at surface enough to reach the stationary point. Two identical balloons of the same volume are pumped up with air to more than atmospheric pressure and suspended on the ends of a stick that is horizontally balanced. The impact of an alpha particle
on a nitrogen nucleus transmutes nitrogen into oxygen: 8 9 7 7 2+ 20 4 2 He 14 7 N 17 8 O Vapor Radioactive trails sample + 1 1 H Rutherford used a device called a cloud chamber to record this event (Figure 13.18). The San Andreas Fault accommodates about 70% of this motion, or about 3.5 cm/yr. The Formation of Sedimentary Rock Sedimentary
rock forms in a long process with four stages: weathering, erosion, deposition, and sedimentation. Loosely speaking, mass corresponds to our intuitive notion of weight. As in the preceding exercise, the force on each cart is the same. cience is the present-day equivalent of what used to be called natural philosophy. A common misconception is that a
rocket is propelled by the impact of exhaust gases against the atmosphere. Rank the average gravitational forces from greatest to least between (a) the Sun and Mars, (b) the Sun and the Moon, and (c) the Sun and Earth. With each collision, heat was released because of the conversion of kinetic energy to heat energy—impact heating. The slope
curves because there are proportionally more neutrons in the more massive atoms. The precise value of absolute zero (0 K) is -273.15°C. 113. 108 PA R T O N E P H Y S I CS FIGURE 4.33 Elliptical orbit. Which atoms have the greater average speed in a mixture: U-238 or U-235? Imagine, however, that one person begins to ease off on the rope. The
loudness of a sound is most closely related to its (a) frequency. (e) NF3. A key player who helped solve the puzzle of continental drift was Harry Hess (Figure 21.15), a geology professor who also served as a naval captain during World War II. Because oxygen is a group 16 element, an oxygen atom gains two electrons to form an O 2- ion. Friction
between a sliding desk you're pushing and a smooth linoleum floor is less than between the desk and a rough floor. This fact was employed in guiding electrons onto the inner surface of early television tubes to produce pictures. How many moles of atoms are there in: (a) 28 g of nitrogen, N2; (b) 32 g of oxygen, O2; (c) 16 g of methane, CH4; (d) 38 g
of fluorine, F2? One megawatt (MW) equals 1 million watts. Shoot the two of them at an apple at the same kinetic energy. This is a most intriguing effect. Is it in equilibrium during this brief moment? (a) water freezing into ice crystals (b) aftershave or perfume on your skin generating a smell (c) a piece of metal
expanding when heated, but returning to its original size when cooled (d) breaking a glass window (e) gasoline in the engine of a car producing exhaust 8. Nitrogen gas or very dry air between the panes. Also, neon doesn't gain additional electrons because
there is no more room available in its outermost shell. The longest-lived stars are those of (a) low mass. Which law of thermodynamics is the conservation of energy applied to thermal systems? The Big Bang marked not only the beginning of space. It employs more loops of wire and is therefore more sensitive. In order to save the conservation of energy applied to thermal systems?
form a product, reactants must collide in a certain S-18 O D D - N U M B E R E D S O LU T I O N S orientation with sufficient energy. * Evidence of a noticeable pressure difference over a 1-m or less difference in elevation is any small helium-filled balloon that rises in air. 4 9 Two refractions and a reflection in water droplets produce light at all angles
up to about 42°, with the intensity concentrated where we see the rainbow at 40° to 42°. Friction between solid surfaces doesn't depend on speed. Suggest an explanation for why aspirin has a sour taste. If a material is impure, it is a mixture and contains two or more elements or compounds. Rather, within the atom there must be a number of distinct
energy levels, analogous to steps on a staircase. In polar regions, the Sun's rays strike at an angle, so solar energy is spread out and dispersed and these regions are cool. CHAP TER 27 are small and faint and are difficult to detect. Nature's rules are beautifully elegant and these regions are cool. CHAP TER 27 are small and faint and are difficult to detect. Nature's rules are beautifully elegant and these regions are cool.
modern-looking page layout design. CHAPTER 5 F L U I D M E CH A N I CS 127 F I G U R E 5 .1 7 The Falkirk Wheel has two balanced, water-filled caissons, one moving up while the other moves down. Does 1 L of water, or more than 1 L of water, Packause two fluoride ions are
needed to balance each calcium ion, the formula for calcium fluoride is CaF2, as Figure 15.9 illustrates. It simply states the universal law of gravitation, which applies to all products. Squeezing the vapors to a smaller volume effectively increases their concentration and, hence, the number of collisions between molecules. For elements in which the
fundamental units are two or more atoms bonded into molecules, the elemental formula is the chemical symbol followed by a subscript indicating the number of atoms in each molecule. Show that the pH of a solution is -0.301 when its hydronium-ion concentration equals 2 moles/L. The aircraft that generated this shock wave may have broken through
the sound barrier hours ago! A B C C H A P T E R 10 WAV E S A N D S O U N D 255 The moving source need not be "noisy" to produce a shock wave. The quasar shown in the center is billions of light-years behind this cluster of galaxies. 4 Cr(s) + 3 O2(g) h 2 Cr2O3(g) 3. If it were somehow knocked off its orbit (unlikely because it's so massive), then
it too would show a tail as it came closer to the Sun. C onvection in Earth's mantle and slab-pull cause the lithospheric plates to move slowly, but constantly. FIGURE 26.5 Sunspots on the solar surface are relatively cool regions. Which is hottest? Thermal energy can move from lower to higher temperatures only when external work is done on the
system. The acid forms the negatively charged ion. Do they glow brighter if they are connected in series or in parallel? Is inertia a property of matter or a force of some kind? 2 3 Pigs have no sweat glands and therefore cannot cool by the evaporation. E X E R C I S E S (SYNTHESIS) 42. An object in free fall accelerates toward Earth at
10 m/s2 (or, more precisely, at 9.8 m/s2). If Venus were somehow transported into the habitable zone, would conditions once again become favorable for life? Use data from Table 17.1 to confirm your estimation. It is, of course, much dimmer than the Moon. In an effort to overcome the multiple ecological negatives of bottled water and a price up to
1000 times that of tap water, many bottled water marketers are now focusing on supposed peripheral benefits of their product. Conduction, convection, and radiation. (CAUTION: Coals can stick to your feet, so ouch—don't try it!) 66. What is the best way to reach its destination, given its present situation?" With the aid of high-speed computers, the
answers to these questions are used to find a new path. As learned earlier, a longer barrel imparts more impulse because of the longer time during which the force acts. 10.8 Doppler Effect 25. uppermost part of the mantle. The benefits, however, include the large-scale production of electrical energy with no emission of carbon dioxide, which is a
potent greenhouse gas. Their color is generally light to dark gray. From carbon? The power and voltage on a compact A 100-W bulb draws about 0.8 A. P-waves are reflected and refracted at the boundary, but S-waves are only reflected. .... F.
 (six). As we cool this solution, the solubility of NaNO3 decreases, as shown in Figure 16.21, and this change in solubility causes some of the dissolved NaNO3 to precipitate (come out of solution). 1 Temperature 6. FIGURE 10.34 Idealized wave pattern made by a bug swimming faster than wave speed. Rearrange the equation Ft = \(\inftig\)(mv) to solve for
the force F. Similar bombardment on Earth has been long erased by erosion. Many homeowners have discovered that it is less expensive and more ecologically sound to install a small reverse osmosis unit within their own home. Reflection The return of a sound wave; an echo. Quartz sandstone is composed of well-sorted, well-rounded quartz
particles. When we say a substance was reduced, we're saying that it gained electrons. Most chemical reactions are influenced by temperature in this manner, including reactions that occur in living bodies. REVIEW 87 of the balls compare upon striking the ground? When they get close to the Sun, they lose volatile compounds, such as water, which
escape and appear as the comet's tail. P4(s) + H2(g) h PH3(g) (a) 4, 2, 3 (b) 1, 6, 4 (c) 1, 4, 4 (d) 2, 10, 8 2. Then would one team of nine horses succeed if the other team were replaced with a strong tree? Thus we see that the combined mass of six free protons and six free neutrons—(6 * 1.00728) + (6 * 1.00867) = 12.09570—is greater
than the mass of one carbon-12 nucleus. When an acid is dissolved in water, what ion does the water form? Another ocean-floor feature discovered was the deep ocean trenches (long, deep troughs in the seafloor) near some continental landmasses, particularly around the edges of the Pacific. FYI R ecall from Chapter 11 that we see white light when
all frequencies of visible light reach our eye at the same time. C onsider a continuous flow of liquid or gas through a pipe: the volume of fluid that flows past any cross-section of the pipe widens or narrows. Use the given conversion factor to convert to units
of light-years: 1 [email protected] = 1.6 [email protected] = 1.6 [email protected] (100,000 AU) 63,000 AU 41. Mathematics is foremost in their tool kits for tackling these questions. FIGURE 9.5 The magnets due to do the same with mine. From iron? Maybe one day we crafty
humans will come to understand such processes. (c) minerals cooled and grew over long periods of time. How does gneiss differ from granite? The pulls of the Moon and Sun are perpendicular, so the solar and lunar tides do not overlap. No, no, a thousand times no! If any moving object were beyond the pull of gravity, it would move in a straight line
and would not curve around Earth. Thus, in hydrogen fluoride, fluorine has a greater electronegativity, or pulling power, than hydrogen. A freely falling object has a speed of 30 m/s at one instant. The layers give this metamorphic rock its characteristic banded appearance. This allows for a greater increase in entropy, which helps with the formation
of products. Compare the crystal shapes of Epsom salts, alum, and sugar. As our use of space grows, so must our ability to predict its weather. If someone is able to explain an idea to you using small familiar words, what does this say about how well that person understands the idea? Oxidation The process whereby a reactant loses one or more
electrons. This transfer of energy cannot involve conduction or convection, for there is no medium between the Sun and Earth. About 80% of this radiation comes from natural sources, such as cosmic rays and Earth itself. The greatest range occurs when the launching angle is 45°—and when air resistance is negligible. Most irregular galaxies F I G U
R E 2 7. FYI A machine can multiply force but never energy—no way! Kinetic energy (of weight) + Heat of molecular motion to Less kinetic energy to Kinetic energy to Heat (kinetic energy Chemical energy of molecular motion) * When you study
thermodynamics in Chapter 6, you'll learn that an internal combustion engine must transform some of its fuel energy into thermal energy. The ability of rubbed straws and test tubes to exert forces through space is due to a property we call electric charge. As a farmer he was a failure, preferring to read books he borrowed from a neighboring
pharmacist. The shadow cast by the blue light appears C H A P T E R 11 LIGHT 279 FIGURING PHYSICAL SCIENCE Solutions: SAM PLE PROBLEMS 1. Highmass stars have shorter lifetimes than low-mass stars. According to Newton, any body attracts any other body with a force that is directly proportional to the product of their masses and
inversely proportional to the square of the distance separating them. (Do you speculate that your present ideas about the world around you will further knowledge and experience solidify your present understanding?) 20. Is the mass of an atomic nucleus greater or less than the sum of the masses of
the nucleons that it contains? As cold air moves into a warm air mass, forming a cold front, the warm air is forced upward (Figure 25.12). 9 Energy and Change of Phase Suchocki burn his bare feet as he steps (quickly) across redhot coals? Why is there a difference? It will float as low when carrying a few tons of Styrofoam as when carrying the same
number of tons of iron ore. CHAPTER 5 1. If there were twice as many coulombs in the test charge relative to the charged sphere be the same, or would it be twice as great? So atmospheric pressure is about 105 N/m2, or about 100 kPa. CHECKPOINT 1.
Amazingly, when listening to music we can discern what instruments are being played, what notes are playing, and what their relative loudness is. A trailing bird gets added lift by positioning itself in this updraft, pushes air downward and creates another updraft for the next bird, and so on. Angular Momentum hings that rotate, whether a cylinder
rolling down an incline or an acrobat T doing a somersault, keep on rotating until something stops them. You are weightless because there is no support force. Is it correct to say that action and reaction forces always act on different bodies? The abbreviation is written with a capital letter because the unit is named after a person. Newton's third law of
motion Whenever one object exerts a force on a second object, the second object, the second object exerts an equal and opposite force on the first object. Observe. The depth of water behind the Hoover Dam is 220 m. Cleavage is the tendency for a mineral to break along such planes of weakness. The three shock waves are produced by supersonic aircraft. The uranium
ores of the Athabasca Basin deposits of Saskatchewan, Canada, are unusually pure, containing up to 70% uranium oxides. This moment has come to be known as the Big Bang, which we will discuss in more detail in Chapter 28. How far will a freely falling object fall from rest in 5 s? The second concept we need to know is that the transparency of
things such as air and glass depends on the wavelength of radiation. C H A P T E R 11 LIGHT 275 F I G U R E 11. When you toss a coin upward, what happens to its velocity while ascending? For those, it is best to use "rainbow" glasses, available from a nature, toy, or hobby store. When connected in series, they form a single pathway for electron flow
between the terminals of the battery, generator, or wall outlet (which is simply an extension of these terminals). Helium, for example, has twice the electric charge of hydrogen but four times the mass. The great benefit of learning this particular conceptual model is that it helps us to understand the organization of the periodic table. This conversion
of hydrogen to helium in the Sun has been going on since it formed nearly 5 billion years ago, and it is expected to continue at this rate for another 5 billion years. By what? This makes it a sphere. The stars within a galaxy, S-28 O D D - N U M B E R E D S O LU T I O N S however, are more concentrated toward the center, so if the galactic collision
were dead-center, then more stellar collisions would occur. At the molecular level, a number of things are going on; for example, energy is used to help separate the bonds between the sodium and chloride ions. (c) Obsidian. Each learning objective begins with an active verb that specifies what the student should be able to do after studying that
section, such as "Calculate the energy released by a chemical TO THE INSTRUC TOR reaction." These section-specific learning objectives are further integrated into the new MasteringPhysics online tutorial/assessment tool. The amount of salt particles, however, is so minute that precipitation is essentially pure fresh water. As in all conductors, the
electrons are already there. Can industries be trusted to self-regulate the amount of pollution they produce? The isotope cesium-137, which has a half-life of 30 years, is a product of nuclear power plants. You can approximate the area of tire contact with the road by tracing the edges of tire contact on a sheet of paper marked with 1-inch * 1
squares beneath the tire. 3 Weight and Weightlessness 4. either side of the rift areas indicate periods of normal and reversed polarity (Figure 21.19). In science courses, the joule is usually preferred. (d) none of these Answers to RAT 1. In free fall, only a single force acts—the force of gravity. In this stream, however, are many insoluble products—
including small plastic items, such as tampon applicators, and gritty material, such as coffee grounds and sand. You know how many valence electrons it has and how many of these electrons are paired. Is the synthesis of ozone, O3, from oxygen, O2, an example of an exothermic or endothermic reaction? The radiation curve of the Sun (see Figure
11.31) shows that the brightest light from the Sun is yellow-green. What is one important difference between dark energy? You can demonstrate this with a spool. Alpha rays carry a positive electric charge, beta rays carry a negative charge, and gamma rays carry no charge. 1 Chemical Equations 17. 5 Reflection and Refraction of
Sound 10. What happens to the wavelength if you dip your finger more frequently? Many require critical thinking, while others are designed to prompt the application of science to everyday situations. Plate Plate Asthenosphere (c) FIGURE 21.21 Plate boundaries are regions of intense geologic activity. One method for making a compass is to stick a
magnetized needle into a piece of cork and float it in a glass bowl full of water, as shown. Electronic synthesizers, for example, produce a vast variety of musical sounds. Today more than 20,000 astrologers are practicing in the United States. The late Millie Hewitt, Leslie's mom, illustrates the cooling effect
of rapid evaporation on page 167. More than half of Jupiter's volume is an ocean of liquid hydrogen. 2 PERIODS Li B Be C N O F Ne Na Mg Al Si P S Cl Ar 4 K Ca Sc Ti Rb Sr Y Zr V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr Rh Pd Ag Cd In Sn Sb Te I Xe 5 Nb Mo Tc Ru alkaline, a term derived from the Arabic word for ashes, al-qali. Of course, more
than a single loop is used. TUTORIAL: Momentum and Collisions 64 PA R T O N E P H Y S I CS FIGURE 3.4 If the change in momentum occurs over a long time, then the hitting force is small. The four commons phases of matter are solids, liquids, gases, and plasmas. If the attractions between the particles are not strong enough, the particles may
separate to form a gaseous phase. 1. Other fossils are simply an impression, or print, made in the rock before it hardened. The second and the fourth structures are the same. To illustrate this concept, consider what happens when the strong acid hydrogen chloride is added to water and what happens when the weak acid acetic acid, C2H4O2 (the
active ingredient of vinegar), is added to water. Look at a globe to see that the oceans cover about 71% of Earth's Surface. Ocean Igneous Rocks Beneath Earth's Surface Sierra Nevada batholith. The fundamental source is
vibrating electric charges, which emit vibrating electron is a tiny magnet. As we will see in the following chapters, moving things possess momentum and kinetic energy. Fossil evidence suggests that the periods of no protective magnetic
field may have been as important in changing life forms as X-rays have been in the famous heredity studies of fruit flies. Two people of equal mass attempt a tug-of-war with a 12-m rope while standing on frictionless ice. An unbalanced chemical equation shows the reactants and products without the correct coefficients. Twice the power means that
the engine can do twice the work in the same amount of time—or it can do the same amount of work in half the time. The environmental lapse rate varies from place to place and from day to day—it can even vary over the course of a day! The average environmental lapse rate is a decrease of 6.5°C for each kilometer rise in elevation. What does
Pascal's principle have to do with their delight at your arrival? CHECKPOINT Is the exothermic reaction in a hydrogen-oxygen fuel cell an example of electrolysis? Surface friction between water and wind, driven by temperature and pressure differences, set the currents in motion. Don't worry if you don't understand things right away—just keep on
reading. Pour vinegar onto beach sand from the Caribbean and the result is a lot of froth and bubbles. All bulbs are identical in the three circuits. When an object falls in a vacuum, the net force is simply the weight, and the acceleration is g (the symbol g denotes that acceleration is due to gravity alone). When the road is wet, however, it is smoother
with less diffuse reflection, and therefore more difficult to see. In swimming, you interact with the water push against each other. * This force acts at right angles to the surface. One vibration per second is 1 Hz; two vibrations per second is 2 Hz, and so on. When the
electric force overcomes the strong nuclear force, however, the protons fly apart from each other. A second way to identify a reaction as an oxidation-reduction reaction is to look to see whether an element is gaining or losing oxygen atoms. This is what happens to sodium chloride in water. The hydrogen bond is also of great importance in the
chemistry of the large molecules, such as DNA and proteins, that are found in living organisms. S cience deals only with hypotheses that are testable. Interactions at plate boundaries create stress, which produces strain in the rock. Earth radiation; the Sun emits shortwavelength radiation. At the submicroscopic level, solid
liquid, and gaseous phases are distinguished by how the submicroscopic particles hold together. For the NiMH battery, this chemical is nickel hydride, H: Ni. For a traditional car battery, this chemical is simply lead, Pb, which transforms into lead sulfate, PbSO4, as it releases electrons. The necessary condition is thermal equilibrium because only
then do the thermometer and thing being measured have the same temperature. We use the Mohs scale of hardness (Table 20.1) to compare the hardnesses of different minerals. The pressure in the shower stall is reduced with fluid in motion, and the relatively greater pressure outside the curtain pushes it inward. In the hot cup the molecules that
constitute the tea are moving faster than those in the cooler cup. Astrology mimics science in that astrological predictions are based on careful astronomical observations. An electric device does not "use up" electricity but rather energy of the atoms in the
product molecules is due to their being more tightly held together. How about a piece of chromite? The +11 sodium atom of Figure 15.4, for example, has one electron in its valence shell, which is the third shell. Its desalination plants, such as the one shown here, have a combined generating capacity of about 4 billion liters per day. Any object
composed of an elastic material, when disturbed, vibrates at its own special set of frequencies, which together form its characteristic sound. There are many obstacles to recycling fresh water. The fist can't exert any force at all unless what is being hit exerts the same amount of reaction force. During a chemical reaction there is a change in the way
 atoms are bonded together. That which stayed behind to react with sulfur dioxide, however, was predominately water containing the heavier isotope of hydrogen, known as deuterium. opposite sides. The darkness of the clear night sky was a mystery to astronomers. Reverberation Re-echoed sound. A vacationer floats lazily in the ocean with 90% of
her body below the surface. A simple series circuit is shown in Figure 8.29. CHECKPOINT A 1-kg ball of U-235 is at critical mass, but the same ball broken up into small chunks is not. 3 The celestial sphere is an imaginary sphere to which the stars are attached. This was a strange finding because, today, animals and North America plants of these
regions are notable for Europe their striking differences. If we subtract the eastward movement of the Sun, the solar day we experience becomes 24 h. A chemical property of oxygen is that it intensifies burning. A third way to increase the rate of a reaction by
lowering its activation energy. What physical property of hydrocarbons is used in fractional distillation? As with any machine, forces can change while work involves both a force and a distance. A saturated aqueous solution of sucrose contains 200 g of sucrose and 100 g of
water. Myth: Lightning never strikes the same place twice. (d) A hydroxide ion is a water molecule plus two extra electrons. Hold the balloon in the palms of both hands and shake rapidly. Then, closer to Earth's surface, the rock cools, contracts, and sinks. The net force on the needle is zero. Only the second law is a probabilistic statement and has
exceptions. This ability to rotate can give rise to numerous conformations (spatial orientations) of an organic molecule. Impulse The product of the fork a tiny push. Minerals are identified by crystal
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APPENDIX B: Vectors A-8 APPENDIX C: Exponential Growth and Doubling Time Odd-Numbered Solutions Glossary Photo Credits Index A-12 S-1 G-1 P-1 I-1 The Conceptual Physical Science Photo Album T HIS IS A V ERY PER SONA L BOOK, a family undertaking shown in the many photographs throughout. But how does magnitude relate to the
energy released by an earthquake? (b) Silicon and oxygen are less dense than iron. The impact speed is 2 km/h, (100 km/h - 98 km/h), a small bump. (The mass of Earth is 6 * 1024 kg, and its radius is 6.4 * 106 m.) 37. Is coal a chemical sedimentary rock? The largest is Titan, 1.6 times as large as our Moon and even large.
than Mercury. Your answer will be in centimeters. We are literally breathing one another. When a hammer hits a stake and drives it into the ground, the stake exerts an equal amount of force on the hammer that brings it to an abrupt halt. Now the gas Water, H2O pressure above the liquid is lower than before. The first convincing candidate for a
black hole, the X-ray star Cygnus X-1, was discovered in 1971. Yet notice how high the giants are on the luminosity scale—they are very bright. When we lift a load against Earth's gravity, work is done. (d) the Sun. The rotation is continuous as long as current is supplied. This time delay lowers the average speed of light through the material (Figure
11.6). Subtractive primary colors The three colors of absorbing pigments—magenta, yellow, and cyan—that, when mixed in certain proportions, can reflect any color in the simplest sense, a force is a push or a pull. The work-energy
theorem similarly tells us that the longer the distance over which the force acts, the greater the change in kinetic energy. When this atom loses an electron, the result is a positive ion. Scanning probe microscopes can also be used to move individual atoms into desired positions. Molecular computing, in turn, may then be eclipsed by other novel
approaches, such as quantum or photon computing, also made possible by nanotechnology. There are three structural isomers for compounds that have the formula C5H12, 18 for C8H18, 75 for C10H22, and a whopping 366,319 for C20H42! A carbon-based molecule can have different spatial orientations called conformations. 5.2 Pressure 4. To
compensate for this, airplanes are pressurized; the additional air needed to fully pressurize a 747 jumbo jet, for example, is more than 1000 kg. Of the atoms sodium, Na; magnesium, Mg; and aluminum, Al, one tends to lose three electrons, another tends to lose one electrons. FIGURE 18.27 INTERACTIVE
FIGURE The hydrogen-oxygen fuel cell. What would happen to the structure of a balloon if it could be inflated to the size of the Sun? CHECKPOINT The structure of 6-aminohexanoic acid is the following: OH H2N O Is this compound a suitable monomer for forming a condensation polymer? A gram or two of water is placed in a dish that is insulated
from the base by a polystyrene cup. Which has greater resistance: a thick wire or a thin wire of the same length? As the Nazca Plate is pulled downward, marine sediments are scraped off onto the granitic roots of the Andes. In this way, the boiling temperature of the water is increased to more than 100°C. So, faults and related earthquakes can also
be found intraplate—far from present plate boundaries— in areas that were once closer to plate boundaries. The opposite charges electrically attract one another. 54. Moving a greater distance in the same time means a greater speed. The diameter of the Milky Way galaxy is about 100,000 light-years. Unconformity A break or gap in the geologic
record, caused by erosion of preexisting rock or by an interruption in the sequence of deposition. Explain why. The unusually bright comet McNaught passed close to the Sun in early 2007. What do you suppose they contain? This meant that the galaxies were not static islands. The total (net) momentum is zero. If the tank and its contents expanded at
the same rate, no overflow would occur. The answer is, in the electrons of the atoms that make up the magnet. Date Dec. (CAUTION: If you try this, be sure to place your hand high above the nozzle at first and then lower it slowly to a comfortable distance above the nozzle. The photo shows Steve Hewitt and high above the nozzle at first and then lower it slowly to a comfortable distance above the nozzle.
opposite forces would have to act on the car for cancellation. The cosmic background microwave radiation tells us that it has cooled to an average of about 3 K. Ethanol is also widely used as an industrial solvent. Moon rocks can be no older than the time of the Moon's formation, about 4.5 to 4.3 billion years ago. If one lamp burns out, the other lamps
are unaffected. Rift (rift valley) A long, narrow gap that forms as a result of two plates diverging. (To avoid information overload, we have not treated this distinction in the text.) Acceleration is the rate at which velocity changes. Similarly, when you walk through the upright coils in the security system at an airport, any metal you carry slightly alters
the magnetic field in the coils. Warning: Do not actually do this. The first law is a restatement of Galileo's concept of inertia; the second law relates acceleration to its cause—force; and the third is the law of action and reaction. Near the Sun, planets and comets travel along curved paths because of the curvature of space. R E A D I N E S S A S S U R
A N C E T E S T (R AT) If you have a good grasp of this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. Why do different isotopes of the same element have the same photon that was incident on the glass. How does
the downward pressure of the 76-cm column of mercury in a barometer compare with the air pressure at the bottom of the atmosphere? In the spinning disk, matter collected in some regions more densely than in others. What is the relationship between water's high specific heat capacity and the climate of Europe? Inductance measures the tendency
of a coil to resist a change in current because the magnetism produced by one part of the coil opposes the change of current in other parts of the coil. If gravity is not a force, then what is it? The molecules position themselves such that the positive side of one faces the negative side of a neighbor. A cloud must have sufficient vertical development;
otherwise, there are not enough droplet collisions for individual droplets to grow. CHAPTER 8 F I G U R E 8 .1 5 F I G U R E 8 .1 6 The larger test charge has more PE in the field of the charged dome, but the electric potential of any amount of charge at the same location is the same location is the same. 117. Such stars inhabit a central place on the main sequence of the
H-R diagram. Hewitt 110: NASA/Goddard Space Flight Center 111: NASA Earth Observing System 119: Sean Mack/Wikipedia 121: Paul G. 146 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Distinguish between thermal energy and temperature.
temperature of the reactants can cause a chemical reaction to go faster. REVIEW 261 65. Nonsilicates Silicates (Silicon and oxygen) Ferromagnesian Biotite Hornblende Augite Carbonates Sulfates Nonferromagnesian Biotite Hornblende Augite Carbonates Sulfates Nonferromagnesian Calcium feldspar
R O CK S A N D M I N E R A L S Oxides Sulfides Hematite Magnetite Aluminum oxides Pyrite Sphalerite Galena Chalcopyrite Orthoclase (potassium feldspar) Clay minerals Phosphates Halides Apatite Halite Fluorite Native elements Gold Copper Silver Diamond Sulfur Nonsilicate minerals make up just 8% of Earth's crust by mass. You, the planets,
and the stars are made of this form of matter, which we will from here on refer to as ordinary matter. The answer is that net force becomes zero. In the outer edges of our solar system, however, matter is simply too sparse for that to happen. The induced dipole-induced dipole attraction is weaker and involves two temporary dipoles. Whenever objects
on a sheet of paper on top of a magnet. red, blue, cyan white red cyan; interestingly enough, the cyan color of the sea is the result of the removal of red light from white sunlight. It is arrogant to think you know it all in the later stages of your education, and stupid to think so at the beginning of your education. Artesian system A system in which
confined groundwater under pressure can rise above the upper boundary of an aquifer. The impact forces between the blue ball and the yellow ball and the yellow ball and the yellow ball and the forming of one C i C bond
and six C i H bonds (2831 kJ/mol), which provides a net release of 1523 kJ/mol of energy. * The speed of a satellite in circular orbit is given by V = 1GM/d, and the period of satellite motion is given by V = 2p 2d 3/GM, where G is the universal gravitational constant, M is the mass of Earth (or whatever body the satellite orbits), and d is the distance of
the satellite from the center of Earth or other parent body. It doesn't make sense to talk about taking an "image" of the inside of an atom. ©t 0.5 h 10 km 1000 m 1h (b) * * = 2.8 m/s h 1 km 3600 s 51. (a) From a = ;a = (one step!). Distance increases as the square of time, so each successive distance covered is greater than the preceding distance
covered. The leaf bobs up and down, but it doesn't travel with the waves. Both physical and chemical changes in volve changes in appearance. Bernoulli's principle? The proportionality constant k in Coulomb's law is similar to G in Newton's law of gravity. Franklin couldn't see which fluid was transferred when the glass was rubbed with silk. 104. Two
fluorine atoms join together to form a covalent bond. most of the energy of the energy
lands on a planet that has the same mass as Earth but half the diameter. Compare and contrast astronomy and astrology, occur—mechanical and chemical. 570 PARTHREEEARTHS CIEN CE for example, is where the Pacific Plate and the slower-moving Philippine Plate collide. Because of these properties, metals are used to build homes,
appliances, cars, bridges, airplanes, and skyscrapers. For example, it should be consistent with the conservation of energy. As long as they all pull with equal force and all maintain the 120° angles, the ring remains stationary, such thing as a "baby" hydrogen bomb. In these respects, science and religion are as different as apples and oranges and do
not contradict each other. Hence, the momentum before an event involving only internal forces is equal to the momentum after the event: mvbefore event = mvafter event hat light is transmitted through the pair of Polaroids
because their axes are aligned. Increase one, decrease the other. (a) Use the formula P = IV to show that the current in the lines is 8.3 A. Owls have extremely sensitive ears. From the shift in the returned frequencies, the speed of the balls is determined and displayed. The farther away the galaxy, the longer its light has been traveling through
                    ace, and hence the greater the cosmological redshift. Any object that has no net electric charge is said to be electrically neutral, and that is where the neutron got its name. On cool, clear nights, objects near the ground cool down more rapidly than the surrounding air. With a little stirring, the sucrose molecules soon mix throug
water. What is the relationship between the light emitted by an atom and the energies of the electrons in the atom? When the ball is held beneath the surface, it displaces a greater weight of water. Energies of the electrons in the atom? When the ball is held beneath the surface, it displaces a greater weight of water. Energies of the electrons in the atom? When the ball is held beneath the surface, it displaces a greater weight of water.
make it the subscript of the chlorine. A common experience illustrating resonance occurs when you are on a swing. Principle of flotation A floating object displaces a weight of fluid equal to its own weight. (c) expand and likely lodge in your throat. The nonmetallic elements, with the exception of hydrogen, are on the right side of the periodic table. Q
= cm©T = (1 cal/g # °C)(20 g)(90°C - 30°C) = 1200 cal. \leq H3O\leq Hydronium ion C H A P T E R 18 (a) T W O CL A S S E S O F CH EM I C A L R E AC T I O N S (b) 461 (c) FIGURE 18.9 ability to conduct an electric current, as Figure 18.9 illustrates. Lifting the barbell, however, is a different story. 26.3 The Inner Planets Why does Venus, not Mercury,
have the hottest surface of any planet in the solar system? 3 108 Hz 103 nm Infrared 1010 Hz Ultraviolet 1012 Hz 10-5 nm Gamma rays 1022 Hz 1024 Hz High frequency 266 PA R T O N E P H Y S I CS Further still is visible light, which makes up less
than a millionth of 1% of the measured electromagnetic spectrum. The magnitude of the field at any point is simply the force per unit of charge. Something similar occurs in the recording head of a tape recorder: magnetic domains in the tape moves past a currentcarrying coil. In the box on the right, you should have drawn all
the particles in random places as in the right side of the first box. Mercury FIGURE 26.8 Mercury is heavily cratered from the impacts of many meteorites. A cotton ball is dipped in alcohol and wiped across a tabletop. Why won't a transformer work in a dc circuit? Time This is 60-hertz current [one cycle per second is called a hertz (Hz)]. (Graphite is
also preferable to lead in pencils because it is less toxic.) 526 PARTHREEEARTHREEARTHREEEARTHR
and the first to direct it to the nighttime sky and discover mountains on the Moon and the moons of Jupiter. Why doesn't a transformer work with direct current? Hewitt 520: Corbis/Photolibrary 524: Mike Keim-Marin Minerals 525: (a, b) Dorling Kindersley 525: (b) Rob LavinskyiRocks.com 525: (c) Rob LavinskyiRocks.com 525: (d) Harry Taylor/Dorling Kindersley Media Library 525: (e) Rob LavinskyiRocks.com 525: (d) Harry Taylor/Dorling Kindersley Media Library 525: (e) Rob LavinskyiRocks.com 525: (e) Rob Lavin
(e) Rob Lavinsky/ iRocks.com 525: (f) National Institute for Occupational Safety & Health 526: (a) Paul Silverman/Fundamental Photographs, NYC 526: (b) Chip Clark 527: (top) Bob Abrams 527: (top) Bo
transform boundary is where two plates are neither colliding nor pulling apart, but rather sliding horizontally passed each other. If an astronaut in an orbiting space vehicle drops a box of tools, does it crash to Earth also? Ice is less dense than water due to its ice crystals that have open structures. (b) period. The addition of black (e) produces the
finished result (f). A mineral's observable physical properties depend on its inner microscopic properties. In pure water, the hydroxide-ion concentration is 1.0:10 µ7 M. (d) the South Pole. Carbonyl group A carbon atom double-bonded to an oxygen atom; found in ketones, aldehydes, amides, carboxylic acids, and esters. The most common high clouds
are thin, wispy cirrus clouds. (a) 1 mole. Rank these atoms in order of the number of electrons they tend to lose, from fewest to most. A hot apple pie cools more each minute if it is put in a cold freezer than if it is left on the kitchen table. Solid nonmetals are neither malleable nor ductile. We were ready, though, with space probes that flew close
enough to Halley to capture dramatic images of its nucleus. (c) support force. diately results in a buildup of electric charge in both containers. How much more O2 than one might find in regular bottled water? If it has fewer electrons than protons, then it is positively charged. From Q = mLf, m = Q/Lf = (4000 cal)/(80 cal/g) = 50 g. As mentioned at
the beginning of this chapter, on the atomic level, the crystalline structure of sodium Bonds forming Ionic bonds formed Al Al 3 O O O Al 3 2 O 2 O 2 Ruby Aluminum oxide, Al2O3 Al Aluminum atom O Oxygen atom Sapphire C H A P T E R 15 chloride is cubic, which is why macroscopic crystals of table salt are also cubic. Heat death A model for the
end of the universe in which all matter and energy disperse to the point of maximum entropy. Over billions of years this created a sphere of far-out objects just barely held to our solar system. Because of such fundamental differences, molecular computing may one day outshine even the fastest integrated circuits. Why doesn't this upward push cause
the book to rise from the table? In a technique known as medical imaging, tracers are used to diagnose internal disorders. Physical sciences--Textbooks. (1.33 moles O3)a N2 + O2 h 2 NO Reaction Rates EXPLAIN THIS Why does blowing into a campfire make the fire burn brighter? FYI endowed with a wave to guide it as it travels. Electrons on a
radio broadcasting tower are forced to oscillate up and down an antenna 535,000 times each second. For the specific heat capacity c, use 1 cal/g # °C. CHAPTER 6 6.6 T H E R M A L E N E R G Y A N D T H E R M O DY N A M I CS Entropy EXPLAIN THIS Why does the smell of cookies baking in an oven soon fill the room? Why is voltage often referred
to as an electrical pressure, especially when comparing electric circuits and water flow in pipes? A horizontally polarized and elliptically polarized, which are also transverse polarizations. A car is raised a certain distance on a service-station
lift and therefore has potential energy relative to the floor. So partial melting results in magmas of many different compositions and—because these magmas cool to form igneous rocks—a variety of igneous rocks—
the lane of a bowling alley. As a result, the nebula transformed from a large, diffuse, spherical cloud to a much smaller spinning disk with a hot center, as shown in Figure 26.3. As the nebula shrank under the influence of gravity, much heat was released upon the collision of particles. The twinkling of stars results from similar variations in the sky,
where light passes through unstable layers in the atmosphere. What important connection did Maxwell discover about electric and magnetic fields? The energy needed is 4.19 J. But when air is present, the downward net force = weight - air resistance. 0 a. If the speed of sound depended on its frequency, discuss why you would not enjoy a concert
sitting far from the stage—say, in the second balcony. Although rock candy is a crystalline solid, it is not classified as a mineral. (Why can you solve this problem without knowing the magnitudes of the charges?) 43. Give two examples of such minerals. The weight of this air is about 100,000 N. Note that when the action is "A exerts force on B," the
reaction is simply "B exerts force on A." Know that an action force and its reaction force always act on different objects. Yet no concept has inspired more "junk science" than energy. The greater number of interactions per distance tends to slow the light, and the result is a slower average speed. FYI 444 PA R T T W O CH E M I S T RY F I G U R E 1
7.1 8 Hydrogen, H2 Potential energy In an exothermic reaction, the product molecules are at a lower potential energy than the reactant molecules. In accord with Bernoulli's principle, the sheets of paper will move inward together because the air pressure between them is reduced and is lower than the air pressure on the outside surfaces. In many
areas of the Caribbean, North Africa, and the Middle East, desalinized water is the main source of municipal supply (Figure 16.30). Classifying Metamorphic rocks are defined by their appearance and the minerals they contain. (b) An infant gains 10 lb. We do not know the answer to that question, but interestingly enough, most
astrophysical data to date are consistent with a flat universe. False. In the absence of air resistance, why doesn't the horizontal component of a projectile's motion change, while the vertical component does change? Do you agree with your friend? A force external to the system is needed for acceleration. But if the spaceship is accelerating, the floor
moves upward faster than the balls, which are soon intercepted by the floor (Figure 28.10). 468: Charles D. G-8 G L O S S A RY Outer planets orbiting beyond 2 AU of the Sun, including Jupiter, Saturn, Uranus, and Neptune—all gaseous and known as the jovian planets. VIDEO: Model of Refraction A light ray is always at right angles
to its wavefront. Typically, the amount of energy dispersion is significantly larger than the difference in chemical entropies of the products and reactants. (a) F = \mathbb{Q}(mv), the amount of energy dispersion is significantly larger than the difference in chemical entropies of the products and reactants.
same vicinity have the same acceleration. 4 S O M E E S T E R S A N D T H E I R F L AVO R S A N D O D O R S Structure Name Flavor/Odor Ethyl butyrate Pineapple O C O H CH2CH3 O CH2CH2 C H CH3 O C H3C O CH2(CH2)6CH3 O C CH3CH2CH2 O CH2CH3 In
the 1800s most salicylic acid used by people was produced not from willow bark but from coal tar. It takes an infinite amount of time to watch an object fall through a black hole's event horizon. How can a hydrogen atom, which has only one electron, create so many spectral lines? Aristotle attempted to clarify motion by classification. The study of
sound properties is called acoustics. What is meant by partial melting? Partial melting? Partial melting of rocks, resulting in magmas of various compositions. 16.4 Solubility EXPLAIN THIS How can oxygen be removed from water? Recent studies of Galileo's notebooks show that Galileo saw Neptune in December 1612 and again in January
1613. As the water below is heated, droplets form at the bottom of the cold saucer and combine until they are large enough to fall, producing a steady "rainfall" as the water below is gently heated. R O CK S A N D M I N E R A L S 545 LEARNING OBJECTIVE Describe the physical and chemical conditions that give rise to different metamorphic rocks.
Thermonuclear fusion Nuclear fusion Nuclear fusion brought about by high temperatures. Rank the following in order of increasing duration: one minute on the surface of (a) Earth, (b) Mercury, and (c) the Moon. The freezing of water is a physical change because liquid water and frozen water are both forms of water—only the orientation of the water molecules to
one another changes. A sample of radioactive material is usually a little warmer than its surroundings because (a) it efficiently absorbs and releases energy from sunlight. Before its weight decreases by 1%, an apple or any object must be raised 32 km—nearly four times the height of Mt. Everest. Because of these and other similar lines of evidence,
the Big Bang has come to be widely accepted by the scientific community as the most viable explanation for the beginning of our universe. F = G 2 = 6.67 * 10 - 11 N # m2 > kg2 * d 3 2(6.4 * 106 m) 4 2 = 2.5 N. Next we see vertical motion without a horizontal component. For a dying star, however, the bigger they are, the harder they fall. In such a
graph the area under the curve represents the supply of the resource. But if the light is polarized, rotating the filter allows you to block out more and more of the light until it is completely blocked out. Write a letter to your grandparents telling them how you're learning about the connections of nature and distinguishing between closely related ideas.
The current driven by voltage V in a circuit of resistance R is given by Ohm's law, I = V/R. In a classroom demonstration a vacuum pump evacuates air from a large empty oil drum, which slowly and dramatically crumples as shown in the photo. In winter, a heat pump can serve as a heater, moving heat from a cooler outdoors to a warmer indoors.
When you are near an incandescent lamp, turn it on and off quickly. 3 6 A supercluster is a cluster of galactic clusters. (2) Peat is buried by sediments. The steam inside condenses, which can be hastened by cooling the can with a dousing of cold water. Before the reaction, these six oxygen atoms are found in three O2 molecules. (b) lithification. action
because in such solutions there are only a few hydronium or hydroxide ions. Zenith x CHECKPOINT 1. So volcanoes, geysers, and hot springs are all powered by radioactivity. C onsider the girl pitching a ball on the cliff in Figure 4.24. This same trend is seen with strong and weak bases. Interactions between the tip and the surface atoms cause
movements in a cantilever attached to the tip that are detected by a laser beam and translated by a computer into a topographical image. (b) 5 m/s. Strong horizontal winds and icy temperatures flatten and distend the cloud's crown into a characteristic anvil shape. By the same token, the foreign substance also lowers ice's melting point. Information
from the individualized badges is periodically downloaded to a database for analysis and storage. (d) parallel to the normal. A student in my class at the Exploratorium in San Francisco, Jayson Wechter, who was a private detective, located him in 1998 and put us back in contact. t Shades of red highlight vulnerable students and challenging
assignments. Such a star does not shrink to become a white dwarf. A microwave oven works similarly. The vehicle later traveled to the hills to analyze their composition. Risk can vary for different groups. A sustained flow needs 
How many more electrons can fit in the valence shell of a hydrogen atom? How are two structural isomers similar to each other? The silicates are the most common mineral group, making up more than 90% of Earth's crust. If over the coming years the annual growth rate remains at half this value, 3.5 percent, then all this would take place in a
doubling time of two decades. Sodium carbonate (Na2CO3) has a 2 - charge in the carbonate ion (CO3)2- to which calcium and magnesium are more attracted than to the 1 - charge in a molecule of soap. When one mass is doubled, the force between it and the other one doubles. The clock at the back end of the ship by the engines, which corresponds
to the bottom floor of the skyscraper, will run slower than the clock at the front end, which corresponds to the top of the skyscraper. We already have polymers that are stronger but much lighter than steel. Strictly speaking, the liquid is not sucked up; it is
pushed up the straw by the pressure of the atmosphere. Phosphates, though not as common as the other mineral groups, are an important agricultural resource. This thermonuclear reaction, converting hydrogen to helium, releases an enormous amount of
radiant and thermal energy, as discussed in Chapter 26. Seismic waves travel faster in hard, rigid rock and slower in unconsolidated sediment or artificial fill. Harrington/Space Telescope Science Institute 748: (bottom) Mark Garlick/ Photo Researchers, Inc. 491 492 PART WOCHEMIST TWOCHEMIST TWOC
FIGURE 19.2 Three conformations for a molecule of pentane. A frequently used secondary level of treatment, shown in Figure 16.38, involves passing the primary effluent first through an aeration tank. Show that the final temperature of the mixture is 31.4°C. How does the frequency of vibration of a small object floating in water compare to the
number of waves passing it each second? The electrons in these conductors traveled pathways that avoided atomic collisions, permitting them to flow indefinitely. Nuclear fusion The combining of nuclei of light atoms to form heavier nuclei. For perspective, a DNA molecule is about 2.0 nm wide, while a water molecule is only about 0.2 nm wide. At
position 4, use 16 cm of string, and for position 5, use 25 cm of string. According to cosmic inflation, this uniform temperature was achieved in the moments before cosmic inflation. When monomers are chained together, they can form polymers consisting of hundreds of thousands of atoms per molecule. Similarly, in 10 s it falls 500 m. All igneous
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rock originated as magma. The Moon, however, helps keep Earth's wobble to a minimum. It is customary to express the speed of a wave by the equation v = fl, where v is wave speed, f is wave frequency, and l (the Greek letter lambda) is wavelength. If Einstein was not the greatest physicist, how could we know? Eventually the pressure exerted by
the superheated water exceeds the holding power of the kernel and the water bursts out as a vapor, which causes the kernel to pop. What are some of the clues that help us to determine whether an observed change is physical or chemical? (a) By how much does the potential energy of the block increase? (b) consist of a central body surrounded by
objects moving in elliptical paths. Nearly all commercial ac circuits in the United States involve currents that alternate back ac and forth at a frequency of 60 cycles per second. This activity may include star formation, supernova, or energy-releasing processes at the galactic core. Current-carrying wire If the wire is bent into a loop, the magnetic field
lines become bunched up inside the loop (Figure 9.11). Which is which? As shown in Figure 19.6, each of these electrons is available for pairing with an electron from another atom, such as hydrogen, to form a covalent bond. Show that 4000 cal is needed to melt 50 g of 0°C ice. Gamma rays penetrate several centimeters into solid lead. The work-
energy theorem applies here. These travel at different speeds, which provides investigators with a means of determining the source of the waves. REVIEW 451 56. Show that the output voltage is 12 V. Transform Plate Boundaries Transform Plate Boundaries are locations where two plates are neither colliding nor pulling apart but are rather sliding
horizontally past one another. For example, is cinnamon-scented air a single material or a mixture of two materials? In a simple bar magnetic field is not stable but has changed throughout geologic time. Future humans might synthesize their own elements and produce energy in the
process, just as the stars have always done. Note in Figure 5.41b that the streamlines are more crowded at B than at A for the direction of spin shown. Paleomagnetic studies during the 1950s revealed that the position of the magnetic poles had moved around the globe. So, in the sense used, light means "electromagnetic radiation." This usage may
originate from the fact that the ultraviolet and infrared regions of the spectrum are adjacent to the visible light region. But when you approach what seems to be water, you find dry sand. A common misconception is that radioactivity is new in the environment, but it has been around far longer than the human race. Rather than washing our dirty
hands and clothes with nonpolar solvents, however, we have a more pleasant alternative—soap and water. On which of these hills does the ball roll down with increasing speed and decreasing acceleration along the path? Helium fuses to carbon at the star's center while hydrogen fuses to helium in a surrounding shell. So, near Earth's surface, where
the pressure is greater, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed), and at high altitude, where the pressure is less, the air's density is greater (and a foam brick is more squashed).
touch it a few times in succession as long as your finger remains wet. CHECKPOINT Galileo worked hard to produce smooth surfaces to minimize friction. F I G U R E 7. CHAPTER 21 1. But, surprisingly, the hang time of the greatest jumpers is almost always less than 1 s. W hen a car speeds up, its gain in kinetic energy comes from the work done or
it. d, 9. Identical rays of light enter three transparent blocks composed of different materials. Metal catalysts in a converter speed up reactions that convert exhaust pollutants to less toxic substances. Electromagnetic induction is at work in computers, coffee makers, kitchen stovetops, cordless electric toothbrushes, and devices galore. Lastly, as a
supplement for more on algebraic problem solving in Physics, consider Problem Solving in Conceptual Physics, by Hewitt and Wolf, ISBN 0-321-66258-X. (a) disadvantage: toxic air pollutants; advantage: toxic air pollutants; advantage
recycling; advantage: provides new jobs (d) all of the above 10. 722 PA R T F O U R ASTRONOMY LEARNING OBJECTIVE Summarize the Moon's origin, its phases, and the role it plays in both lunar and solar eclipses. Current divides in a branch, with more passing in the branch of lower resistance. (In this answer we avoid using the term force to
describe gravity. (b) have decreased average speeds. Kr.. What happens to the remaining energy? If the land and water were heated equally by the Sun, such convection currents (and the winds they produce) wouldn't occur. A common pickup for an electric guitar consists of a coil of wire around a small permanent magnet, as shown in Figure 9.26.
The effect that we humans have on global atmospheric conditions is measurable. CHECKPOINT F I G U R E 1 9.1 9 Tannins are responsible for the brown stains in coffee mugs or on a coffee drinker's teeth. What name is given to the property by which objects resist changes in motion? Interestingly, most things, from atoms to planets and almost
everything else in between, have springiness to them, and they vibrate at one or more natural frequencies. The symbols in equations are akin to musical notes that guide musicians. (c) A = B = C. Identify any physical or chemical changes. How does the hotness of the rivet also help to make a tight fit when it cools? A buoyant force is acting on you,
and you are buoyed upward by it. He also observed that the P-waves into Earth but then refracted at an angle and lost speed. A fastmoving, turbulent flow can move and carry a range of particle sizes—from the smallest particles of clay to large pebbles and cobbles. Hewitt 493: Pearson Education/Pearson Science 495:
Casey Kelbaugh/AGE Fotostock 505: (top) Eduardo Jose Bernardino/iStockphoto 505: (top) Eduardo Jose Bernardino/iStockph
the stick's balance? In addition to interesting laboratory experiments, it includes a range of activities similar to the activities in the textbook. If a ball has the same speed just before being caught, (b) when it is thrown, or (c) when
it is caught and then thrown back? Can you see that the thickness of the paint decreases as the square of the distance increases? (d) Salt is composed of ions that are too attracted to themselves. The Suchocki's Vermont friend Nikki Jiraff is seen carbonating water on page 417. (b) surface area of the lake. Which of these exhibits behavior more
analogous to that of an electric circuit? Sometimes insulation that separates the wires in a circuit wears away and allows the wires to touch. The right wheel maintains its higher speed while on the sidewalk. The risks became most evident with the 2011 earthquake and tsunami that destroyed the Japanese Fukushima nuclear power plant. Would the
pH go up or down, or stay the same? A metal ball is barely able to pass through a metal ring. These tween ethanol molecules. PE = 5000 J KE = 7500 J FIGURE 3.26 INTERACTIVE FIGURE A circus diver at the top of a pole has a potential energy of 10,000 J. Because catalysts are not consumed by the C
HAPTER17 reactions they facilitate, a single catalytic converter may continue to operate effectively for the lifetime of the structures of ice crystals in a piece of ice compare with the volume of ice that floats above the
water line? The term amplitude refers to the distance from the midpoint to the crest (or to the trough) of the wave. In both chemical and nuclear burning, a high temperature starts the reaction; the release of energy by the reaction maintains a high enough temperature starts the reaction maintains a high enough temperature starts the reaction; the release of energy by the reaction maintains a high enough temperature starts the reaction; the release of energy by the reaction maintains a high enough temperature starts the reaction; the release of energy by the reaction maintains a high enough temperature starts the reaction maintains and nuclear burning, a high enough temperature starts the reaction maintains and nuclear burning, a high enough temperature starts the reaction maintains and nuclear burning and 
a body of water, what type of sediment is left behind? Why don't cumulus clouds form over cool water? This is commonly represented by drawing a circle within the ring, as shown in Figure 19.8b, rather than by individual double bonds. A moving Earth would have to travel at an enormous speed to circle the Sun in one year. Your first experiment is to
launch a clock-bearing probe toward the black hole. Then the shadow of Earth falls on the full Moon. In water, not only H H does the oxygen atom have access to two additional Hydrogen atom have access to an adCovalent bond formed ditional electron by
bonding to the oxygen atom. CHAPTER 6 T H E R M A L E N E R G Y A N D T H E R M O DY N A M I CS 155 more on a hot summer day than in winter. Fission liberates neutrons that convert the relatively abundant nonfissionable U-238 to U-239, which An average ton of coal contains 1.3 parts per million (ppm) of uranium and 3.2 ppm of thorium.
Iceboats (sailcraft equipped with runners for traveling on ice) encounter no water resistance and can travel at several times the speed of the wind when they tack upwind. The important thing about exponential growth is that the time required for the growing quantity to double in size (increase by 100 percent) is also constant. The upward force
required while moving at constant velocity is equal to the weight, mg, of the object, so the work done in lifting it through a height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh: Gravitational potential energy = weight * height per mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that the height h is the product mgh Note that height h is the product mgh Note that he height h is the 
low solubility in water and high volatility, it quickly leaves the bloodstream. "What is the logarithm of 105?" can be rephrased as "To what power is 10 raised to give the number 105?" The answer is 5. Rainwater chemically decays the rock's outer layers, making the rock easier to erode. When we study the nature of light later in this book, we treat
light first as a wave and then as a particle. LIGHT 273 Normal Mirror F I G U R E 11. Because water is most dense at 4°C, colder water rises and freezes on the surface. What we've learned thus far about heat and thermal energy is summed up in the laws of thermodynamics. What distinction is your partner missing? Studies show that only about 20%
of drinking water bottles are recycled. (b) beneath the straight-line path it would follow without gravity. Newton The scientific unit of force. Paul's other brother Dave with his wife Barbara pump water on page 131. 514 PA R T T W O CH E M I S T RY 19.7 Polymers 22. (a) Which has a lower pH: pure water that is hot or pure water that is cold? A
liquid does so only below its surface. Hence, in a neutral 10-2 2 solution, in which the hydronium-ion Vinegar concentration equals 1.0 * 10-7M, the Soft drink 10 -3 3 pH is 7. So we see two reasons for cannons with long barrels producing greater cannonball speeds. Science and religion, however, are basically different. CHAPTER 5 a F L U I D M E
CH A N I CS 137 FIGU R E 5. In what year was the efficient electrolysis of aluminum discovered? For molecule attractions, the amount of energy absorbed or released per gram of material is relatively small. Butane, C4H10? Large but shallow lake 3 m Small but deep pond 6m VIDEO: Dam and Water Molecules that make up a FYI liquid
can flow by sliding over one another. As shown in Figure 19.26, polymerization occurs when two of the electrons from each double bond split away from each other to form new covalent bonds with neighboring monomer molecules. Condensation is a warming process. Some of the oxygen, however, mixes with the water. Magnetic domains Clustered
regions of aligned magnetic atoms. The older the rock, the higher the percentage of these remnant isotopes. When the wagon is pulled forward, the ball rolls against the back of the wagon. Above this, secure a can of water so that you can measure its temperature change when the nut burns. When precipitation exceeds evaporation, salinity decreases
as a new influx of fresh water dilutes the salt solution. O R G A N I C CO M P O U N D S Which of the two is easier to change: the conformation or the configuration of your arm? No attempt is made to return the rocket to its original path. 19.2 Unsaturated Hydrocarbons With four unpaired valence electrons, how can carbon bond to only three
adjacent atoms? † A dry air parcel is an air parcel is an air parcel that is not saturated—its relative humidity is less than 100%. C H A P T E R 10 REVIEW 259 A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 31. Now the pulls are no longer balanced, and the ring begins to move away from the person who is slacking off, as Figure 15.28 shows. A business jet
of mass 30,000 kg takes off when the thrust for each of two engines is 30,000 N. What general rock feature does a geologist look for in a sedimentary rock to determine the distance the rock has traveled from its place of origin? (b) Yes, the speed ball B gained going down the extra dip equals its loss in speed going up the dip, so both balls end up with
the same speed. You can prove something to be unsafe, but you can never prove something to be completely safe. (a) Reactions involving sodium bicarbonate, NaHCO3, cause baked goods to rise. Ion An atom having a net electric charge because of either a loss or gain of electrons. Dropping black soot from an aircraft onto snow-covered mountains is
a technique sometimes used in flood control to accomplish controlled melting at favorable times, rather than a sudden runoff of melted snow. Interestingly enough, the parabolic path of a projectile, such as a tossed baseball or a cannonball, is actually a tiny segment of a skinny ellipse that extends within and just beyond the center of Earth (Figure
4.34a). Instead, light travels in rather straight passes through intense gravitational fields surrounding a star or black hole). C H A P T E R 11 3 of many atoms Glass molecules. Once in motion, if there is no net force to change the state of motion, it moves at an unchanging speed and is in dynamic equilibrium. E = mc 2 says that
mass is congealed energy. 6 Electromagnetic Induction 9. You are pouring air from one glass into another! 37. What is the function of an atomic model? What two forces act on you while you are in a moving elevator? The voltage of a cell depends on the materials used and the conducting solution they are placed in, not the size of the plates. Note the
tiny bubbles that adhere to the inner sides of the pot. Engineers were quick to grasp the idea of integrating many transistors together to create logic boards that could perform calculations and run programs. For longer distances, the deflective Coriolis force is influenced by Ekman transport, which causes water to spiral in a gyre. The radius
decreases as the mass of the hole increases because the increased mass, and hence gravity, makes it harder for light to escape. FYI one way, magnetic force pushes the electromagnet toward the permanent magnet, pulling the cone inward. Add at least a dozen tarnished pennies to the solution. CHAPTER 1 REVIEW R E A D I N E S S A S S U R A N C
ETEST(RAT) If you have a good handle on this chapter, if you really do, then you should be able to score 7 out of 10 on this RAT. Magnetic field Direction of wave travel In a vacuum, all electromagnetic waves move at the same speed, differing only in frequency. Assuming the same habitability, however, we can suggest how human civilization
might be different by considering how the Moon has influenced our history and worldview. (a) Solid Further heating causes the submicroscopic particles in a liquid to move so fast that the attractions they have for one another are unable to hold them together. The initial step in all wastewater treatments, therefore, is to screen out these insolubles.
How does the speed of car B compare with the initial speed of car A? It is a law of constancy during change. How does the settling of various materials in the peanut butter jar mimic the distribution of Earth's elements? As the droplets grow, they eventually fall at the same rate as the updraft, becoming more or less stationary. High-resolution data
from very distant galaxies showed that space, beginning about 7.5 billion years ago, started to accelerate in its expansion. How wonderful that energy transforms from one form to another! CHAPTER 3 MOMENTUM AN D ENERGY 77 FIGURING PHYSICAL SCIENCE Problem Solving SAM PLE PROBLEM Acrobat Art of mass m stands on the left end
of a seesaw. That's because although liquids and gases are different phases of matter, they are both fluids, with much the same mechanical principles. First, charge the balloon by rubbing it on your hair. Do amines tend to be acidic, neutral, or basic? Very slow motion produces hardly any voltage at all. So the energy from fossil fuels is delayed solar
power. Air in this situation is very stable—the denser, cooler air cannot rise above the less dense, warmer air, and so it resists vertical movement. It accelerates during the interval of braking, the auto's velocity and acceleration are in opposite directions. As a
glacier, or ice sheet, moves over the land, it gouges the surface. As the carbon of methane, CH4, forms carbon dioxide, CO2, it is losing hydrogen and gaining oxygen, which tells us that the carbon of methane, CH4, forms carbon dioxide, CO2, it is losing hydrogen and gaining oxygen, which tells us that the carbon of methane, CH4, forms carbon dioxide, CO2, it is losing hydrogen and gaining oxygen, which tells us that the carbon of methane, CH4, forms carbon dioxide, CO2, it is losing hydrogen and gaining oxygen, which tells us that the carbon of methane, CH4, forms carbon dioxide, CO2, it is losing hydrogen and gaining oxygen, which tells us that the carbon is being oxidized.
than is indicated here. I. Apply the same force over an extended period of time, and you produce a greater change in the automobile's momentum. According to Figure 19.3, gasoline travels higher than kerosene, so it must have a lower boiling point. What physical phenomenon underlies beats? The sky is overcast, and it is raining. Such lettering is
seen in readable form in the rearview mirrors of cars ahead. The importance of this law was recognized only after the first, second, and third laws had been named, hence the name "zeroth" seemed appropriate. For an initial speed greater than 8 km/s, the satellite an ellipse. Advances made in the physical sciences, such as our understanding of the
chemistry of life, however, will likely propel the life sciences to even more fantastic advances in the 21st century. The minus sign of downward values of velocity indicates a downward direction. Is octane an element or a compound? In general, the younger a star, the greater amounts of these heavier elements it contains. T H I N K A N D R A N K (A N D R A N E N D R A N K (A N D R A N D R
A LY S I S ) 38. If you spray some drops of coffee into a vacuum chamber, they boil until they freeze. They feel weightless because of the absence of a support force. Hewitt Addison Wesley Longman, Inc./San Francisco (top) Addison We
(left) Paul G. 16 kg # m/s = 16 N # s. A friend asks what force pushes the ball to the back of the wagon. Avogadro's number The number of particles—6.02 * 1023 —contained in 1 mole of anything. Because slight variations in gravity produce these effects, might not slight variations in the planetary positions at the time of birth affect a newborn? A
basic solution? Plug and Chug (Formula Familiarization) The purpose of these one-step, quick, non-intimidating calculations is familiarization with the equations and hydrogen react with the zinc chloride and manganese dioxide
ZnCl2(aq) + 2 NH3(g) h Zn(NH3)2Cl2(s) 2 MnO2(s) + H2(g) h Mn2O3(s) + H
travel time For example, if your average speed on a 4-h trip is 80 km/h, then you cover a total distance of 320 km. The Sun, for example, with its approximately 5800 K surface temperature, emits most strongly in the middle of the visible spectrum and so appears yellow. What chemical change occurs when a wax candle burns? Acid Proton donor h
Base Proton acceptor h In the Brønsted-Lowry definition, an acid is any chemical that donates a hydrogen ion. A nitrogen nucleus that accepts a hydrogen ion, H+, and a base is any chemical that donates a hydrogen ion. A nitrogen nucleus that captures a neutron, for instance, becomes an isotope of carbon by emitting a proton: 6 8 7 7 1 0 A 1-g sample of carbon from recently living matter contains
about 50 trillion billion FYI (5 * 1022) carbon atoms. An ultimate long-term solution, however, would be a shift from fossil fuels to cleaner energy sources, such as nuclear and solar energy. Mars and Earth spin on their axes at about the same rate, which means the lengths of their days are about the same. (c) both of these (d) none of these 8. Any
activity, whether a sports game, computer game, or the game of life, is meaningful only if we understand its rules. Cl Cl C C Longer distance between positive and negative charges 52. (Remember—each color of visible light corresponds to a different frequency.) A spectroscope, shown in Figure 12.22, is an instrument used to observe the color
components of any light source. All these solutions have the same concentration. Plants and animals were energized by the Sun before they became fossil fuels. Alcohol wiped across a tabletop rapidly disappears. In units of light-years, what is the approximate diameter of our solar system, including the outer reaches of the Oort cloud? T H I N K A N D
SOLVE (MATHEMATICALAPPLICATION) 47. As a result, rhythmic patterns of compressed and rarefied air emanate from the loudspeaker, showering the entire room with undulating motions. Each of these elements in the
period to which a particular group 18 element belongs. 14.3 Physical and Chemical Properties 10. We have become so accustomed to the benefits of technology that we are only faintly aware of our dependency on dams, power plants, mass transportation, electrification, modern medicine, and modern agricultural science for our very existence. (a)
6.02 * 1023 (b) 8.38 * 1020 (c) 1.51 * 1023 (d) More information is needed. These were the forerunners of modern batteries. The most common foliated metamorphic rocks—slate, schist, and gneiss—are derived from sedimentary rocks that have the appropriate chemical composition to favor mica formation (Figure 20.35). Looking at it in a Newton's-
third-law way, when the immersed block pushes 10 N of fluid aside, the fluid reacts by pushing back on the block with 10 N. From spacecraft data, scientists have been able to account for why the atmospheres of Venus and Earth are so different. Do astronomers make stellar observations during the full Moon part of the month or during the new Moon
part of the month? One prototype model, shown in Figure 16.29, disinfects 15 gal/min, weighs about 15 lb, and is powered by photovoltaic solar cells, which permit it to run unsupervised in remote locations. Meteoroid A small rock in interplanetary space, which can include a fragment of an asteroid or comet. Subtle energy, of course, cannot be
detected by current science, but the effects on your health, they claim, can be most dramatic. Aldrin, Jr., one of the three Apollo 11 astronauts, stands on the dusty lunar surface. 6.2 Absolute Zero 4. Instead, it flows from the hot tack to the cooler water. If the gas is heated until its hydrogen molecules have doubled their kinetic energy, what is its
temperature? (c) dependent on the internal battery resistance. Denser oceanic crust therefore has a lower vertical position than the less-dense continental crust, just as the loaded ship sits lower in the water than the unloaded ship. Add a base to water, and the reverse happens. It was the seismograms of this network of stations that revealed details
of the unseen structure of our planet. 10 Sources of Energy concept of inertia is incorporated into Newton's first law of motion. Which melts more ice before cooling to 0°C? Evidence suggests that the Oort cloud consists of trillions of objects extending as far out as 50,000 AU, which brings the cloud about a quarter of the way to the nearest star.
Please explain. Methane is the main component of natural gas. Alloys of iron differ; soft iron is easier to magnetize than steel. Glass, however, is opaque to ultraviolet light and therefore shields you from sunburn. E Why does heat added to boiling water not increase its temperature? Workers in underwater construction work in an environment of
compressed air. A solar eclipse occurs during the day as the new Moon passes in front of the Sun. A practical application of the wave properties of fast-moving electrons waves. Each pull is the same in magnitude. c, d, b, a. With no specific source of the radiation
where were the microwaves coming from and why? Jupiter is more than 300 times as massive as Earth, so it might seem that a body on the surface of Jupiter would weigh 300 times as much as it weighs on Earth. SAM PLE PROBLEM 1 If the air density is 1.25 kg/m3, what is the volume of the air mass? Could you cook an egg in this boiling water?
Vertical motion only with gravity Combined horizontal and vertical motion Superposition of the preceding cases F I G U R E 4 .1 4 INTERACTIVE FIGURE Simulated photographs of a moving ball illuminated with a strobe light. Many homeowners get their drinking water piped up from wells dug into their property. 2 Pressure 5. 9 Efficiency 3. That's
a trade secret, but rumor has it that there are microscopic pits in the metal pan that help the Teflon adhere physically. These two compounds, heptane and isooctane, are used as standards in assigning octane ratings to gasoline. Similarly, a neutron star stops collapsing because neutrons, like electrons, resist trespassing into their neighboring
neutrons. (b) weight. Perhaps what happens to the mass that falls into the singularity is even stranger than we're capable of imagining. Is the frequency of the echoed chirps it receives higher, lower, or the same as the emitted ones? Mercury is a fairly bright object in the nighttime sky and is best seen as an evening "star" during March and April or
as a morning star during September and October. Countless generations have wondered about our place in the universe. More simply, these are called the north and south poles. Watch for the formation of copper metal on the amplitude of the
waves, which causes stronger ground shaking. Current The danger from car batteries is not so much electrocution as it is explosion. If the glass when sudden temperature changes occur. Acknowledgments W e are enormously grateful to Ken Ford for extensive feedback on the
sound (Mach 1.41). This net force is the buoyant force. CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E 779 F I G U R E 2 8 .11 (a) An outside observer sees a horizontally, the ball strikes the wall below a point opposite
of the 48 g O3 b = 64 g O3 reactants, as it must be because of the 1 mole O3 law of mass conservation. We see this in Figure 4.31, where, for the sake of simplicity, the payload is the entire universe. Note the direction of light, indicated by the blue arrow (the light arrow (the light) are the number of observable universe.
negatively charged? The force vector in Figure B.13 decreases as the boat travels faster. When disorder increases, entropy incr
For less than orbital speeds, the center of Earth's center, for a circular orbit, both foci are Earth's center; for greater speeds, the near focus is Earth's center. But body oils are also soluble in paint thinner feel dry and chapped. We see that in one 6 32 63 doubling time we use more than all that
ASTRONOMY F I G U R E 2 8 .1 INTERACTIVE FIGURE Every ant on the expanding balloon sees all other ants moving farther away. The count decreases to 40 counts per second (one half-lives), and 5 (4 half-lives), and 5 (4 half-lives). Restoring the original conditions restores the original appearance: frozen water melts upon warming. If
we consider cosmic rays heading toward Earth from all directions and from great distances, those descending toward northern Canada are moving nearly parallel to the magnetic field lines of Earth. By playing around with u Mh u proportions, metal workers can readily modify the u Mh u properties of an alloy. Adjusting them is quite simple: what you
see is what you hear. What colors of ink do color ink-jet printers use to produce a full range of colors? CHAPTER 3 61. Suppose you fall from a bridge and manage to grab a high-voltage power line, halting your fall. 3 7 Each cloud represents a supercluster. Instead of seeing nothing, your brain graciously fills in the appropriate background. If the ball
were somehow thrown at the speed of light, both curvatures would be the same. E arth's Moon is puzzling. Change the configuration of pentane, however, and you no longer have pentane to know that generators don't produce energy—they simply convert energy from some other form to electric energy. Mountain ranges, volcanoes,
plutonic rocks, metamorphic rocks, and folded and faulted rocks are all explained by plate tectonics. Recent findings show that many insects increase lift by employing motions similar to those of a curving baseball. Compare the momentum of a 1-kg cart moving at 10 m/s with that of a 2-kg cart moving at 5 m/s. If we are concerned with direction—
down, for falling objects—we say the diver has reached terminal velocity. It does this by detecting the electrical forces between the tip of the microscope's needle and the outer electrons of the atom. (Consider a dog with a relatively massive tail.) 83. With how much force does magnet B then pull on magnet A? (a) A second layer of water would form
Mechanical weathering physically breaks rocks into smaller and sma
accelerates to the right. Why bother using a machine if it cannot multiply work input to achieve greater work output? The standard unit of mass is the kilogram, abbreviated kg. This greater mass causes the air pressure to be higher, which in turn creates denser air. 458 PA R T T W O CH E M I S T RY CHECKPOINT Identify the acid or base behavior
of each participant in the reaction: H2PO4 \mu H3O \mu m H3PO4 \mu H2O Was this your answer? A black hole has the same amount of mass after its collapse as before its collapse, so the gravitational field in regions at and beyond the star's original radius is no different in either case. Sound needs a material medium for its transmission; light does not
Keep in mind that rock is an aggregate of solids, so the melting of rock into magma occurs over a broad temperature range. Using a breeder reactor is like filling your car's gas tank with water, adding some gasoline, then driving the car and having more gasoline after the trip than at the beginning! The basic principle of the breeder reactor is very
attractive, for after a few years of operation a breeder-reactor power while breeding twice as much fuel as its original fuel. Coulomb's law can be expressed as F = k q1 q2 d2 LEARNING OBJECTIVE Relate the inverse-square law to electrical forces. There is a third way—by changing a current in a nearby
loop. Can an acidic solution be made less acidic by adding an acidic solution? What are the units of measurement for weight and for mass? cm. 71 Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu Lanthanides 90 91 92 93 94 95 96 97 98 99 100 101 102 103 Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr Actinides 12.5 Physical and Conceptual Models
EXPLAIN THIS How do we predict the behavior of atoms? 376: (top) US Mint 376: (middle) Shutterstock 377: Theodore Gray 378: (top) Claire Maxwell/ Pearson Education 378: (top) Claire Maxwell/ Pearson Education 378: (top) Claire Maxwell/ Pearson Education 378: (top) US Mint 376: (middle) Shutterstock 379: Theodore Gray 378: (top) Claire Maxwell/ Pearson Education 378: (top) Claire Maxwell/ Pearson Education 378: (top) US Mint 376: (middle) Shutterstock 379: Shutterstock 379: Theodore Gray 378: (top) Claire Maxwell/ Pearson Education 378: (top) US Mint 376: (to
while cooler air aloft sinks. Note again that the unit of time, the second, appears twice. The fusion of heavier elements in our Sun, however, is not possible. Eventually, many of them collide with the nuclei in the denser lower atmosphere. CHECKPOINT What causes electric shock: current or voltage? Scientists must keep open minds, must be prepared
to accept new findings, and must be ready to be challenged by new evidence. We are free to choose this frame's location and to have it moving relative to another frame. Induced dipole - induced
make up the matter around you, from stars to steel to chocolate ice cream. This is different from the way we use this term in Chapters 20 and 22, where deposition refers to the laying down of sediment. 3.9 Efficiency 26. You would need about 94 trillion Earth-size populations to have an Avogadro's number of people. For people of the C H A P T E
surface are lava flows most common? Place the slit over an incandescent filament glows at all visible frequencies. When the bird is soaring, the wing must be shaped so that moving air particles are deflected downward. In a similar manner, the Moon aligns with
Earth's gravitational field. What changes in cosmic-ray intensity at Earth's magnetic field is passing through a zero phase while undergoing pole reversals? * The death toll was largely due to great seismic sea waves, or tsunami. How many atoms of arsenic are there in a 145-g sample of
(b) One second before reaching its highest point, its velocity is 10 m/s. Einstein's general theory of relativity, which he had proposed ten years earlier in 1905. This photograph also shows Comet Hyakutake, which appeared in 1996. Energy is required to reduce the speed of a moving object or to
bring it to a halt. Was this good news or bad news for the Statue of Liberty, whose copper exterior was originally held together by steel rivets? The coin, on the other hand, doesn't have enough time to fall fast enough for air resistance to build up to equal its weight. Which is more polar: a carbon-oxygen bond or a carbon-nitrogen bond? We can
better understand how gravity is diluted with distance by considering how paint from a paint gun spreads with increasing distance (Figure 4.5). Then in the 1990s, some 40 years after Einstein's death, two teams of astronomers made a startling discovery. Magnesium ions carry a 2+ charge, and chloride ions carry a 1- charge. Consequently, it must
take off and land at high speeds. Mutual gravitation between the gaseous particles in a protostar results in an overall contraction of this huge ball of gas, and its density increases still further as matter is crunched together, with an accompanying rise in pressure and temperature. Because the nuclear fires of a white dwarf have burned out, it is not
actually a star anymore, but is more accurately called a stellar remnant. (d) Excess chlorine is absorbed in our bodies as a mineral supplement. On regular ground, they are not so obvious. Rank the tension in the left rope, from greatest to least, in the three situations A, B, and C. Why can't he hit a sheet of tissue paper in midair with the same amount
of force? When connected in parallel, they form branches, each of which is a separate path for the flow of electrons. The magnetic field of an individual iron atom is so strong that interactions among adjacent atoms cause large clusters of them to line up with one another. Water that is safe for drinking is said to be potable. Hydrogen tends to form
covalent bonds because, unlike the other group 1 elements, it has a fairly strong attraction for an additional electron. Beyond the planets, space is almost flat, and objects travel along nearly straight-line paths. (a) High clouds: cirrus, cirrostratus, cirrostratus,
contains much more information. We know that speed is defined as distance divided by time. Some of the busiest airports in Europe were forced to close down for several days. A cluster of electrons need not be accompanied by a cluster of protons, and vice versa. Show that the force of gravity is 3.5 * 1022 N between Earth and the Sun (Sun's mass
2.0 * 1030 \text{ kg}; average Earth-Sun distance = 1.5 * 1011 \text{ m}). This explains why plastic wrap sticks not only to polar materials such as glass but also to itself. When he first hears three beats per second, the tuner knows he is 3 \times 1011 \text{ m}. This explains why plastic wrap sticks not only to polar materials such as glass but also to itself. When he first hears three beats per second, the tuner knows he is 3 \times 1011 \text{ m}.
directly above the focus is called the epicenter. When the forcing frequency matches the natural frequency of the surface, the result is resonance. As shown in Figure 17.5, for example, 2 moles (4 g) of molecular hydrogen react with 1 mole (32 g) of molecular oxygen to give 2 moles (4 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 mole (32 g) of molecular hydrogen react with 1 molecular hydrogen react with 1
VIDEO: Low Temperature with Liquid Nitrogen hen you touch a hot stove, thermal energy enters your hand because the stove is warmer than your hand. This rising of air is accompanied by the sinking of cooler air aloft—convectional lifting. A permanent magnet produces a magnetic field in a region where a rectangular loop of wire is mounted to
turn about the axis shown by the dashed line. What is the relationship between a white dwarf and a nova? Soon you can't make out the clock at all because it has shifted to the infrared. F I G U R E 2 0 .1 5 Rocks are made of minerals. New green technology is another fix—converting vehicles to run on clean, renewable electric power. C H A P T E R 12
ATO M S A N D T H E P E R I O D I C TA B L E 313 wavelengths in the wire. The bug undergoes an enormous and lethal deceleration, while the bus undergoes are different! The bug undergoes are different! The bug undergoes an enormous and lethal deceleration, while the bus undergoes an enormous and lethal deceleration.
of the bus is unnoticed by its passengers. What orientation of the wire is likely? x = 5,400,000,000 yr 764 PA R T F O U R ASTRONOMY For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Active galactic nucleus The central region of a galaxy in which matter is falling into a
supermassive black hole and emitting huge amounts of energy. A rocket becomes progressively easier to accelerate as it travels through space. Oceanic lithosphere is thin and young near the spreading ridge. (f) What is the change in velocity, ov, during the 2-s interval from 1 s before the highest point to 1 s after the highest point? Now reduce the
opening between your lips so the air expands as you blow. Nanotechnology allows the continued miniaturization of integrated circuits needed for ever smaller and more powerful computers. Give two reasons for the slowing, one in terms of a horizontal friction force between Freddy's feet and the skateboard, and one in terms of momentum
you wish to change your answer to the preceding question?) Remember, reading check questions provide you with a self-check of whether or not you grasp the central ideas of the chapter. Massive Jupiter likely disrupted the orbits of this material, sending it off in many directions, including toward the inner planets and out of the solar system. Figure
19.16 shows two appropriately named amines, putrescine and cadaverine, which are partly responsible for the odor of decaying flesh. Note that the paper does not catch fire. 6 Atmospheric Pressure 5. The laws of electromagnetic induction were discovered at about the time the American Civil War was being fought. Furthermore, the water that
acts on the bookcase when it is at rest on a horizontal surface without being pushed? When no air resistance acts on a projectile, its horizontal acceleration is (a) g. Moisture condenses and precipitates as air cools Cool air depleted of moisture sinks and warms Moist, warm air rises dow CHAP TER 25 INTERACTIVE FIGURE Cumulonimbus Warm air
abruptly lifted Warm air mass Warm surface winds Cold air 695 F I G U R E 2 5 .1 2 Cirrus Cold air mass D R I V I N G F O R CE S O F W E AT H E R A cold front occurs when a cold air mass moves into a warm air mass. You drink a small glass of water that is 99.9999% pure water and 0.0001% some poison. What surface feature do Jupiter and the
Sun have in common? The oxygen we breathe, O2, is converted to ozone, O3, in the presence of an electric spark. (c) both the direction and the energy. So we can calculate that the methane reacted with 64 g of oxygen, which, interestingly enough, is 2 moles, as shown in the equation. TUTORIAL: Chemical Reactions and Equations A s was discussed
in Chapter 14, during a chemical reaction, atoms rearrange to create one or more new compounds. When you first formulate your own answers, you'll find yourself learning more—much more! Aristotle would probably say that the ball stops because it seeks its natural state of rest. Water molecules in the water are themselves polarized. As we learned
in Section 11.2, light slows down when it enters glass, and it travels at different speed in different speed in air, and at about three-fourths that speed in water. Watch for their implementation in the near future. These vehicles produce very few pollutants and can run much more
efficiently than vehicles that burn fossil fuels. Given that Earth is about 4.5 billion years old, why is there any radium at all? Surprisingly, the idea of energy was unknown to Isaac Newton, and its existence was still being debated in the 1850s. How might you distinguish a sodium-vapor streetlight from a mercury-vapor streetlight? Meteorologists use
numerical models and computers not only to plot and analyze data but also to help predict the weather. For example, when an apple falls from a tree, we say it is interacting with the gravitational field of Earth, but we can also think of the apple as interacting with the mass of Earth, but we can also think of the apple falls from a tree, we say it is interacting with the gravitational field of Earth.
coffee table. You feel its heat, but you find when you touch the bulb that it is not hot. Everything with any temperature above absolute zero emits radiant energy. A lower environmental lapse rate indicates that temperature above absolute zero emits radiant energy.
direction by wetting your finger and holding it up in the air. Gasoline is nonpolar, so salt and gasoline will not interact very well. Rank the following in order of increasing abundance in the universe: (a) dark matter, (b) ordinary matter, (c) dark energy. A stagnant pond smells worse than a babbling brook because (a) odors are not transported
downstream. Classify each of the following as an element, compound, or mixture, and justify your classifications: salt, stainless steel, tap water, sugar, vanilla extract, butter, maple syrup, aluminum, ice, milk, cherry-flavored cough drops. Start stacking pillows and the stack gets taller. Why is the air over an open flame always moist? Hess called his actually start stacking pillows and the stack gets taller.
hypothesis seafloor spreading. For example, hematite and magnetite are valuable iron oxide ores used for steelmaking and construction. Review the discussion of soaps in Section 16.5, and then draw the likely chemical structure for this alcohol. An airplane flies upside down by tilting its fuselage so that there is an angle of attack of the wing with
oncoming air. Seismic-wave research has revealed the architecture of Earth's internal layers (Figure 21.4). Calculating G alone was first done by the English physicist Henry Cavendish in the 18th century, a century after Newton's time. When the net force on something is zero, we say that the object is in mechanical equilibrium.* In mathematical
notation, the equilibrium rule is \boxtimes F = 0 The symbol \boxtimes stands for "forces acting downward to make the vector sum equal zero. Good emitters of radiant energy are also
percentage of nuclear power plants in operation today are based on nuclear fusion? First of all, most minerals are actually quite rare. As an impoverished country, Haiti cannot rebuild itself—relief efforts for Haiti will need to continue for many years. From the transformer relationship, secondary voltage primary voltage 120 V 5 = = = . A perfectly
black surface emits what is called blackbody radiation and has an emissivity of 1. When I exhale, I'm releasing into the air many of the atoms that were once a part of me. As a living organism, the diver has a supply of biochemical energy, obtained ultimately from photosynthesis, that he can tap to climb upward against gravity to get back to the diving
platform. These so-called T waves were among the purest 260 PA R T O N E P H Y S I CS sounds in nature. The obstetrician exerts twice the gravitational force on mM 2m2M 4mM the baby! 43. Looking at the periodic table, we calculate that the formula masses for MgO, FeO, and SiO2 are 40 amu, 72 amu, and 60 amu, respectively. Its apparent
curvature would become negligible. (Hint: Exactly what is between us and the mountains we see?) Were these your answers? What would happen if, in his exuberance, he gave the bob a slight shove as it left his nose? The greater the velocity with
which it is receding. How is it possible to cause an endothermic reaction to proceed when the reaction causes energy to become less dispersed? 272 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Describe how refraction is caused by changes in wave speed. Different atoms and molecules have different "spring strengths." Electrons in glass have a
cause potential harm. If one or more electrons are lost or gained, as illustrated in Figures 15.4 and 15.5, the balance is upset and the atom takes on a net electric charge. If the sail is oriented at an angle, as shown in Figure B.14, the boat will move forward, but with less acceleration. Theorists have various ideas about the nature of dark energy,
including the possibility that it may be Einstein's famed cosmological constant. The first shell, for example, has the capacity for only two electrons. After LEARNING OBJECTIVE Compare and contrast three scientifically possible fates of the universe. Show that the net force acting on it is 200,000 N. (From energy conservation: Total energy = KE
PE.) 97. The greater the impulse exerted on something, the greater the change in momentum. A long helically wound coil of insulated wire is called a solenoid. The right side shows representative vertical cross-sections for the map views to the left. The result is increased temperature. Atomic size is a periodic (repeating) property. Action and Reaction
on Different Masses Quite interestingly, a falling object pulls upward on Earth with as much force as Earth pulls downward on it. The arts are concerned with personal interpretation and creative expression. Table 19.3 lists three simple amines. In 1900, Planck hypothesized that light energy is guantized in much the same way matter is. Why doesn't
Jupiter is larger than the smallest stars, which, though smaller than Jupiter, are about 80 times as massive. The risks posed by nuclear power plants are involuntary because each smoker chooses to smoke. Find a Ping-Pong ball on the next clear day when
between two points, measured in volts and often called voltage difference. Farther away are water-rich, low-temperature minerals such as muscovite and chlorite. 96 PA R T O N E P H Y S I CS pods at the end of a tether will likely replace today's nonrotating space habitats. So we see why a satellite in circular orbit moves parallel to the surface of
Earth at constant speed—a very special form of free fall. Why is there so little wind on the surface of Venus? The volume of an air bubble depends on the surrounding water pressure. See Vehicles Average speed, 25-26 Avogadro's number, 432 B Banded iron formations, 629 Barometers, 130-131 Barrier islands, 656 Basalt, 536, 538 Bases, 455-470
 Name at least two ways that thermal energy in air can be increased. The body temperature of animals that regulate their internal temperature, such as humans, is fairly constant. She should sit half-a-meter closer to the center. But instead of dying, why doesn't the body simply turn off until oxygen becomes available again? Semipermeable membranes are their internal temperature, such as humans, is fairly constant.
A membrane containing submicroscopic pores that allow the passage of water molecules but not of larger solute ions or solute molecules. In the absence of a force, the planets would follow straight-line paths. Ionic compound A chemical compound A chemical compound A chemical compound Significance of a force, the planets would follow straight-line paths. Ionic compound A chemical compound A chemical compound Significance of a force, the planets would follow straight-line paths. Ionic compound A chemical compound Significance of a force, the planets would follow straight-line paths.
shows, a hydrogen isotope with only one proton is called hydrogen-1, where 1 is the mass number. Every bit of matter, wires included, contains enormous numbers of electrons that swarm about in random directions. I tell this true story to make the point that one's thinking is very different when there is a rule to guide it. 1 2 same electrical
characteristics as the Susan B. Which contributes more to an atom's mass: electrons or protons? This relationship, which was discovered by Charles Coulomb in the 18th century, is called Coulomb's law. Unlike a compass needle that aligns with Earth's magnetic field, the proton's axis wobbles about the applied magnetic field. It is amorphous and so
is not a mineral. If all the molecules in a liquid had the same speed, and some were able to evaporate, would the remaining liquid be cooled? 26 Sunlight passing through a prism separates into a color spectrum. Because biology sits at the top of these three sciences, it can be considered to be the most complex. (c) The sample is being cooled and the
material is condensing, 605: (top) Lane V. An exception is the giant elliptical galaxy M87 (Figure 27.25). When an alpha particle is ejected, the nucleus loses two protons and two neutrons. In contrast, a scalar quantity can be specified by magnitude alone. A boulder is thrown into a deep lake. Chemistry sets the foundation for the major Earth sciences
—geology, oceanography, meteorology. Try holding single pennies on your left and right index fingers. A shortcut way of solving this sort of problem is to take the charge of one ion and make it the subscript of the opposite ion. c, b, a. Ice crystals in nearly frozen liquid water CHAPTER 6 T H E R M A L E N E R G Y A N D T H E R M O DY N A M I CS
157 Volume (mL) FIGURE 6.22 1.09 1.08 1.07 1.06 1.05 1.04 1.03 1.02 1.01 1.00 Ice Water vapor Liquid water 0 1.0016 1.0014 100 Temperature (°C) 1 Liquid water and iron, silver atoms are about twice as massive as iron atoms. Light then passes through your lens, which provides the
extra bending power needed to focus images of nearby objects on your extremely sensitive retina. High clouds (above 6000 m) 3. In effect, the animal becomes cold-blooded, which is what happens to bears and ground squirrels when they hibernate.
the event: mv before event = mvafter event Law of mass conservation Matter is neither created nor destroyed during a chemical reaction; atoms merely rearrange, without any apparent loss or gain of mass, to form new molecules. With the unaided eye, it looks like small dim fuzz. All three of these transformations involve a change in the way the
atoms in the molecules are chemically bonded to one another. How successful will she be at canoeing upstream in a river that flows at 8 km/h? Galileo would probably say that friction overcomes the ball's inertia, and brings it to a stop. What does this tell you about their relative
densities? An awareness of both the short-term risks and the longterm risks of a technology is crucial. into the atmosphere than when they are cold. (c) The fresh water acts to dissolve the blood cell wall. M ost moving things undergo variations in their motion. What are the basic differences and similarities between a generator and an electric motor?
Thus dark matter is invisible to light as well as to our sense of touch. The color of shale provides clues to the environment of formation. 9.10 Field Induction 28. LEARNING OBJECTIVE Distinguish noise from musical sounds. Half reactions are useful for showing which reactant loses electrons and which reactant gains them, which is why half reactions
are used throughout this chapter. Water expands when it turns to ice, which is why part of it sticks above the surface. Tenny Lim, former student and now a design engineer for Jet Propulsion Labs, puts energy into her bow on page 72. It appears once for the unit of velocity and again for the time during which the velocity changes. Thermal conduction
occurs by collisions between particles and their immediate neighbors. The absorbed energy is transferred to other atoms as heat, not re-emitted as light, so the glass is opaque at ultraviolet frequencies. But sucrose molecules are so small that there are 6.02 * 1023 of them in only 342 g of sucrose, which is about a cupful. Red Kool-Aid crystals are
added to a still glass of water. Why doesn't this shatter the window? Can you see that it was taken in the summer months of the Southern Hemisphere? 42 PA R T O N E P H Y S I CS CHECKPOINT Force changes motion, it doesn't cause motion. The air pressure in their underwater chambers is at least as great as the combined pressure of water and
atmosphere outside. Within the celestial sphere, Polaris is closely aligned with the North Pole, which marks the axis of Earth's spin. Fronts are usually accompanied by wind, clouds, rain, and storms. A solution that has not reached the limit of solute that will dissolve is called an unsaturated solution. Why will a cat that falls from the top of a 50-story
building hit a safety net below no faster than if it fell from the 20th story? As Figure 15.8 shows, ionic compounds typically consist of elements that are found on opposite sides of the periodic table. It can be both helpful and harmful. Conversely, high-silica minerals melt at lower temperatures than do low-silica minerals. When the bug swims faster
than wave speed, it produces a pattern of overlapping waves, ideally shown in Figure 10.34. (b) Rank the voltage across each, from greatest to least. (a) Show that flows through the battery. If you are so lucky as to be in a location
where the clear night sky is free from city lights, you must try to find the Andromeda galaxy. Without greenhouse gases in the atmosphere, Earth's surface would average a frigid - 18°C. Titan, however, holds an intriguing soup of organic molecules whose chemistry may provide a clue to what Earth was like during the time before life arose here.
Floodplain A wide plain of almost flat land on either side of a stream channel. The walls of the barn are still cold. This is where stratospheric ozone forms. If the rocket needs a minimum speed of 11.2 km/s. (a) none (b) one (c) two (d) three 9. 83. Tangential speed is directly proportional to the
distance from the axis (for a given rotational speed). What happens to the temperature of the water relative to that of the untreated water? Additionally, the process of crystallization enriches magma in silica. (c) Yes, the average speed of ball B dipping down and up is greater than the average speed of ball A. Cooler air from above the cool water takes
its place and convection currents are formed. This is shown in Figure 1.10. What is the reading in the righthand scale? So you decide to move on to the second experiment, for which you have volunteered to place yourself within a second probe equipped with a blue clock and an array of telescopes. This form of evaporation is called sublimation. So,
what the magnetic surveys of the ocean's floor actually revealed was not magnetic intensity but magnetic direction. Adiabatic Processes in Air VIDEO: Adiabatic Processes in Air
milliarcseconds (about 8 cm or 3 inches)! Think of how an ice skater in a spin varies that spin by the extension of her arms. Particle traps filter out soot particles from exhaust fumes. The same is true when you look at a fish in water. When you push downward on a book at rest on a table, you feel an upward force. No, it wouldn't. Mohorovic i'c
discontinuity (Moho) The crust-mantle boundary; marks one of the depths where the speed of P-waves traveling through Earth increases. The bag of flour is attracted to Earth with a gravitational force of 2 lb—or equivalently, 9 N. When a 134-Hz tuning fork and a 144-Hz tuning fork are struck, the beat frequency is (a) 2 Hz. (b) 6 Hz. (c) 8 Hz. (d)
more than 8 Hz. 10. The fact that the net force on the desk equals zero means that the force of friction must be equal in magnitude and act opposite to our pushing force. (d) the atmosphere against which the rocket pushes. What happens if she instead heats the ring (as shown): does the size of the hole increase, stay the same, or decrease? There are
far more galaxies within the entire universe than there are stars in our galaxy. So, even though it is fairly uniform in composition, the mantle varies in its physical properties. In the process of sedimentation, sediments are deposited horizontally one layer at a time. This invisible form of matter that we cannot see or touch is known as dark matter. Sn.
If an iron nucleus split in two, its fission fragments would have (a) more mass per nucleon. If these peaks are shifted toward the red, then we know the galaxy must be receding away from us. Pour about a quarter cup of water into a gallon or 5-liter metal can with a screw top. Bang theory? Technologies involving different risks for different people, as
well as differing benefits, raise questions that are often hotly debated. You can breathe a bit easy because the time frame for this is about a billion years. Hint: Use the Periodic Table to find atomic mass units, then express the formula for pyroxene as a sum of its constituent atoms. The process continues as the three spheres interact to influence
landforms at Earth's surface. All nuclei beyond iron in atomic number were in fact manufactured in supernovae. The Magdeburg hemispheres demonstration used two teams of horses for showmanship and effect: a single team and a strong tree would have provided the same force on the hemispheres. Astrology means different things to different
people, but in any case, it is far outside the realm of science. Periods mark changes within eras and are considered the most useful time intervals to document change. EXPLAIN THIS T F I G U R E 2 6 .1 4 Jupiter, with its moons Io (orange dot over planet), as seen from the Voyager 1 spacecraft in February
1979. Cherry-flavored cough drops, a pharmaceutical, are a mixture. In this case entropy is (a) decreasing. Both are in equilibrium because both are not accelerating. For example, large particle sizes are deposited in energetic environments, such as the
middle of a lake or the center of the ocean. Period A horizontal row in the periodic table. It is interesting to note that the accuracy with which an unoccupied rocket reaches its destination is not accomplished by staying on a planned path or by getting back on that path if the rocket strays off course. 142 PARTONEPHYSICS 69. Luminous stars
are near the top of the diagram, and dim stars are toward the bottom. Scientists point to the sixth mass extinction as occurring right now. Use the formula speed = distance/time and solve for time; then convert the units from seconds to minutes: 150,000,000 km time 150,000,000 km = 500 s Time = 300,000 km/s (500 s)(1 min/60 s) = 8.3 min
300,000 km/s = 39. 28.4 Dark Matter How is it possible to detect something in space that we can't see through our telescopes? This has been the case in our study of physics thus far, but more so with what now follows. The idea that blood is attracted by a magnet is bunk. Magnitude refers to the earthquake's size and the amount of energy it releases
Newton made corrections in the experimental data used in his earlier method and obtained excellent results. Thus, as author Paul and wife Lillian illustrate in Figure 2.29, we cannot touch without being touched. If the field changes in a closed loop, and the loop is an electric conductor, then both voltage and current are induced. THINKANDSO
LVE (MATHEMATICALAPPLICATION) 41. Newton's stroke of intuition, that the force between Earth and an apple is the same as the force that acts between moons and planets and everything else in our universe, was a revolutionary break with the prevailing notion that there were two sets of natural laws: one for earthly events and an apple is the same as the force that acts between moons and planets and everything else in our universe, was a revolutionary break with the prevailing notion that there were two sets of natural laws: one for earthly events and an apple is the same as the force that acts between moons and planets and everything else in our universe, was a revolutionary break with the prevailing notion that there were two sets of natural laws: one for earthly events and everything else in our universe, was a revolutionary break with the prevailing notion that there were two sets of natural laws: one for earthly events and everything else in our universe, was a revolutionary break with the prevailing notion that there were two sets of natural laws: one for earthly events and everything else in our universe, was a revolutionary break with the prevailing notion that there were two sets of natural laws: one for earthly events and everything else in our universe, was a revolution and everything else in our universe, which is the prevailing notion that the prevailing natural laws: one for earthly events and events and everything else in our universe.
altogether different set for motion in the heavens. Magma Molten rock in Earth's interior. A droplet of ink in an industrial ink-jet printer carries a charge of 1.6 * 10-10 C and is deflected onto paper by a force of 3.2 * 10-4 N. MRI was formerly called NMRI (nuclear magnetic resonance imaging), because hydrogen nuclei resonate with the applied
fields. 6 Naming Compounds 14. A gas at a high pressure has many gas particles crammed into a given volume. Organic molecules that contain it are therefore acidic. Marshall Ellenstein, a contributor, editor, and producer of Paul's DVDs on physics, walks barefoot on broken pieces of glass on page 143. Emission of an alpha particle decreases the
atomic number by 2. Clusters and Superclusters Galaxies are not the largest structures in the universe; they tend to cluster into distinguishable groups. If it has more electrons than protons, the object is negatively charged. A practical application is triggering highway traffic lights. (The direct proportionality of v to r is not valid for the planets
because planets don't all have the same v.) 1.5 m 5m FIGURE A.8 The lever arm is still 3 m. CONSERVATION LAWS A conservation law specifies that certain quantities in a system remain precisely constant, regardless of what changes may occur within the system. CHAPTER 20 20.9 Metamorphic Rocks EXPLAIN THIS Why are gems usually found in
metamorphic rocks? Radio waves travel at the same speed as every other electromagnetic wave—the speed of light. You see, not only is Earth moving at a great speed, but so are the tree, the bird that sits on it, the worm below, and even the air in between. (c) (a) (b) (d) ripples and a wavy appearance make the cirrocumulus
clouds look like the markings on the body of a mackerel. C H A P T E R 18 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S 469 CHECKPOINT What kind of lakes are protected against the negative effects of acid rain? What has been discovered is a layered planet. When the climate warmed, the glaciers melted and sea level rose. + -1e 205?
How do dolphins perceive their environment in dark and murky water? 470 PARTTWOCHEMISTRY FIGURE 18.17390 CO2 concentrations of atmospheric carbon dioxide since they began collecting data in the 1950s. 6 Failed
Planet Formation so much energy? During a severe storm, the difference in outside and inside pressure doesn't need to be very much. Some thermal energy escapes by conduction through the glass and stopper, but this is a slow process, because glass, plastic, and cork are poor conductors. (b) For this reason, they are often represented by a circle
within the ring. The force that you exert on the ground is greater than your weight because you momentarily accelerate upward. Why, then, don't the communication satellites that "hover motionless" above the same spot on Earth crash into Earth? Nanotechnology generally concerns the manipulations of objects from 1 to 100 nanometers in size. The
solubility of a solute is its ability to dissolve in a solvent. A rock is defined as an aggregate of minerals (Figure 20.15). Because of its low density, however—about onefourth of Earth's. The air is adiabatically compressed, and so its temperature increases. So there's some merit in the old adage that
wishing hard for something makes it come true. On the West Coast, air moves from the Pacific Ocean to the land. Equate these two equations for acceleration and show that, for constant mass, Fot = O(mv). The ball would be in circular orbit. In a strong wind, however, pressure is reduced on the windward side (Bernoulli's principle) and the forces no
longer cancel to zero. Take a moment to locate the Sun on the H-R diagram. Schist rocks are shiny with obvious foliation. A clock at Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's surface runs slower than a clock located farther away. C H A P T E R 16 MIX TURES 397 F I G U R E 1 6.1 Earth's s
draw more current or less current than a lamp with a thin filament? Bayer didn't regain these rights until 1994 for a steep price of $1 billion. 1 Acids Donate Protons; Bases Accept Them 18. 16.6 Purifying the Water We Drink 18. For example, if the time interval is increased by a factor of 100, the force is reduced to a hundredth. The magnetic field
about the current-carrying wire makes up a pattern of concentric circles. To politicians it means 'go away and come back when you're certain.'" Pretend you are a scientist with strong but inconclusive evidence in support of impending climate change. Hewitt 75: (left, right) Michael Vollmer/Paul G. An example of a strong acid is hydrogen chloride,
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HCl, and an example of a strong base is sodium hydroxide, NaOH. 18.3 Acidic, Basic, and Neutral Solutions EXPLAIN THIS Why can't water be absolutely pure? It means that one of the battery terminals is 12 V higher in potential than the other one. Law of universal gravitation Every body in the universe attracts every other body with a force that, for
two bodies, is directly proportional to the product of their masses and inversely proportional to the square of the distance separating them: m1 m2 F = G 2 d Parabola The curved path followed by a projectile under the influence of constant gravity only. What effect does your distance from the plane mirror have on your answer to the preceding
exercise? Although most of the energy is released during the main quake, some of the energy comes before—foreshocks—and some comes after—aftershocks. As the tapped glass is being filled, does the pitch of the sound get higher or lower? (c) equals the evaporation rate. Volume and mass are proportional only when the materials are identical—
when they have the same density. What are they? We can then apply the familiar equation that relates speed, time, and distance: Based on these estimates, the age of the Atlantic Ocean is about 190 million years. A dipole is a vector quantity possessing both magnitude and direction. * To some degree, measuring instruments change what is being
measured—ammeters and voltmeters included. Levels of radon vary from region, depending on local geology. In every instance, the deflection of starlight has supported Einstein's prediction (Figure 28.15). A solar eclipse occurs at the time of a new Moon, when the Moon is directly in front of the Sun. As wood burns, for example, the atoms
of cellulose molecules break away from each other in order to combine with the atoms of oxygen molecules to form carbon dioxide, water vapor, plus lots of heat. Why is it that a subsonic aircraft, no matter how loud it may be, cannot produce a sonic boom? slowly . FIGURE 10.28 INTERACTIVE FIGURE (a) (b) (a) Shake the rope until you set up a
standing wave of one loop (12 wavelength). The modern scientific theory that satisfies these requirements is called the nebular theory, which holds that the Sun and planets formed together from a cloud of gas and dust, a nebula (Latin for "cloud"). What evidence tells us that Mars was at one time wetter than it presently is? If it is launched vertically
its speed at the top is zero. Said another way, we have determined the age of the universe. (b) What is its wavelength? Velocity is a vector quantity, and a velocity vector at an angle has horizontal and vertical components, as seen in Figure 4.13. 6 Entropy 6. Each set of wheels bends at the boundary due to slowing and is deflected from its initial
straight-line course. To chemists, however, solutions are things that are still all mixed up. Such a current-indicating instrument is called a galvanometer. An important message in science, however, is that uncertainty is acceptable. How does the giant impact theory of the Moon account for this fact? Without a continuous supply of rising air, a cumulus supply of rising air air ai
cloud begins to dissipate. They can also be solid or gaseous, as Figure 16.12 shows. Within weeks, instruments at the Mauna Loa weather observatory on the other side of the planet noted a significant drop in atmospheric levels of methane and its by-product, carbon dioxide. That's because the internal pressure of moving air against the top of the
paper is less than the atmospheric pressure beneath it. Show that the distance between your eye and the image of the spider in the mirror is 1.25 m. Thus, a noble-gas atom tends not to form ions of any sort. To answer these questions, think of a coin and a feather falling in air. Lake Ave., Glenview, IL 60025. So we accentuate differences rather than
similarities. The principle of equivalence states that observations made in a Newtonian gravitational field. In this case, bond (c) rotates in such a way that the carbon at Before After the right end of bond (d) comes up out of the plane of the page, momentarily points
straight at you, and then plops back into the plane of the page below bond (c). 455 LEARNING OBJECTIVE Identify when a chemical behaves like an acid or a base. If Earth had no moon, then Earth's rotation would be much slower and our planet might not be amenable to life. The atoms or molecules in the glass hold the energy for less time, with less
chance of collision with neighboring atoms and molecules, and less of the energy is transformed to heat. When an electron wave is confined to an atom, the consequence is a quantization of the electron's energy. When we measure the temperature of something with a conventional thermometer, thermal energy flows between the thermom(b)
Rotational motion eter and the object whose temperature we are measuring. This reconstruction would bring all the glaciated regions into close proximity near the South Pole and place the modern northern continents nearer to the tropics. Fnet 15 N 5.0 N 35. As material from the mantle oozes upward, new lithosphere is formed. The splint will flameer to the tropics.
up as soon as it makes contact with the oxygen. b, 6. Both Earth and the Moon cast shadows when sunlight shines on them. These changes are the Moon phases (Figure 26.24). This proton-proton repulsion in large atomic nuclei reduces nuclear stability. When one thing is inversely proportional to another, as one gets bigger, the other gets smaller.
"Saltpeter," which is potassium nitrate, KNO3, is useful as a fertilizer and in the formulation of gunpowder. 19.3 Functional Groups 9. Zinc is less dense than copper, so post-1982 pennies are less dense and have less mass than pre-1982 pennies. Magnetic poles cannot be isolated. Because no space is available in the valence shell of a noble-gas atom
no additional electrons are gained. These materials are called superconductors, having zero electrical resistance to the flow of charge. (d) All of the above. LEARNING OBJECTIVE Describe the components of a solution, and calculate a solution, and calculate a solution are gained.
Which has stronger attractions among its submicroscopic particles: a solid at 25°C? Carrying out fusion reactions under controlled conditions requires temperatures of millions of degrees. (d) none of the above 10. At this extreme temperature, protons would be turning into neutrons and neutrons would be turning into protons. What is
a dipole? solution A, 0.5 mole of sucrose in 2.0 L of solution; solution B, 1.0 mole of sucrose in 3.0 L of solution; solution C, 1.5 moles of sucrose in 4.0 L of solution. (b) the two most abundant elements in Earth's crust. Hubble's observations had two major implications. No; induced dipoles are only temporary. Similarly, limestone subjected to enough
heat and pressure becomes marble. 10 N strike the ground if dropped from a rest position 10 m high? Hydrogen is the oldest element. CHECKPOINT Which of these do not emit radiant energy: (a) the Sun, (b) lava from a volcano, (c) red-hot coals, (d) this textbook? ... P. Do you suppose perfluorocarbon molecules are polar or nonpolar? Satellites are
above the atmosphere and air resistance—not gravity! It's important to note that Earth's gravity extends throughout the universe in accord with the inverse-square law. The resulting attraction between the permanent dipole (water) and the induced dipole (water) and the induced dipole attraction. 2 Gravity extends throughout the universe in accord with the inverse-square law.
4. As magma cools, the first minerals to crystallize have the highest (hottest) melting points but the highest silica content (Figure 20.13). Bi.. The shape of an active starburst galaxy tends to be (a) elliptical. Note that only the first letter of an atomic
symbol is capitalized. (a) 100% (b) about 70% (c) about 24% (d) 0% 4. It is important to note that during metamorphism, minerals do not melt. Whether the music is live or electronic, our ears break the overall sound signal into its component parts automatically. A scientific theory, on the other hand, is a synthesis of a large body of information that
encompasses well-tested and verified hypotheses about certain aspects of the natural world. (c) expands and cools. Why is this so? This mirror-image sound signal is fed to earphones worn by the operator. In the case of Pangaea, sea level was low for a long time: 20-25 million years! This undoubtedly placed a great deal of stress on marine organisms
Show that 90 J of work is needed to increase the speed of a 20-kg cart by 3 m/s. The cabbage is purple when you buy it at the store. Hence the boat when driven only by the wind cannot exceed wind speed. The remaining 99% of the carbon in our diet is the more common carbon-12 isotope containing six neutrons per nucleus. For the transverse waves
of light we see constructive interference where crests and troughs of one wave superimpose on another. The conversion of O2 to O3 is therefore a chemical change. Mixed with a plasticizer, the PVC becomes soft and flexible and thus useful for making shower curtains, toys, and many other products now found in most households. Assuming that 20.0
g of sodium chloride has a volume of 7.50 mL, show that she will need about 1.99 L of water to make this solution. Rank, from first to last, the episodes that brought about Earth's uneven distribution of elements: (a) gravitational attraction, (b) radioactive decay heating, (c) density segregation, (d) impact heating. The neutrons, however, keep going
for longer distances because they have no electric charge and therefore do not interact electrically with matter. Momentumafter (5 kg)(1 m/s) + (1 kg)v = 0 - 5 kg # m/s v = = - 5 m/s. F I G U R E 1 .1 8 Instantaneous Speed Moving things often have variations in speed. Which occupies the greatest volume: 1 g of liquid
water, or 1 g of water vapor? Electron vibrations are then transmitted to the vibrations of other electrons in the material. In the previous chapter we defined acceleration to be the time rate of change of velocity; that is, a g (change in v)/time. 7.3 Radiation EXPLAIN THIS How do we know the temperatures of stars? Rays of light striking this page
encounter millions of tiny flat surfaces facing in all directions. Because of this closeness it is the fastest planet, circling the Sun in only 88 Earth days—which thus equals one Mercury "year." Mercury spins about its axis only three times for each two revolutions about the Sun. Why, then, doesn't the atmosphere go off into space? Rank the following in
order of increasing number of atoms: (a) 52 g of vanadium, V; (b) 52 g of chromium, Cr; (c) 52 g of manganese, Mn. 43. Author Paul's first grandchild Manuel Hewitt swings on page 261. If Earth somehow expanded to have a larger radius, with no change in mass, how would your weight be affected? The elemental formula for a 1-carat diamond,
process? (a) pH is a measure of the hydronium-ion concentration. The higher the hydronium-ion concentration, the lower the pH. When you pour a solution of hydrogen peroxide, H2O2, over a cut, an enzyme in your blood decomposes it to produce oxygen gas, O2, as evidenced by the bubbling that takes place. Suppose you cut a small gap in a metal
ring. Cl C Chlorine Carbon Paired valence electrons are relatively stable. (A greater impulse produces a greater change in momentum, so a long cannon imparts more speed to a cannonball than a short cannon does.) Impulse Changes Momentum 3.2 EXPLAIN THIS Why is it a good idea to have your knees bent when you land LEARNING OBJECTIVE
Describe the role of force and time when momentum changes. Do you agree? The sodium ions of soap and detergent molecules carry a 1 + charge (note their positions in the periodic table). CHAPTER 4 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L I T E S 103 and presenting a very small
cross-section to the air, follows an almost perfect parabola when thrown. Is the sailboat sailing at a location closer to the equator? Compressional forces create reverse faults. Just why electrons repel electrons and are attracted to protons is beyond the scope of this book. Point A shows the apparent position; point B shows
the true position. (c) An easy-to-draw cross-sectional view that resembles Bohr's planetary model. Note that the crosshatched area A is equal to the crosshatched area B. He designed a curved paddle that caused the incoming water to make a U-turn upon impact with the paddle. Describe oxygen's physical and chemical properties. If the water is
flowing, the whole conglomeration of grime and soap molecules flows with it, away from your hands or clothes and then down the drain. The constituents of the metamorphosing minerals actually migrate and recombine to form new minerals. In other words, which takes longer to warm in sunlight (or longer to cool at night)? After a hot rivet is
inserted into a hole joining the two plates, its blunt end is rounded with a hammer, which is made easier by the hotness of the rivet. Reflected sound in a room makes it sound lively and full, as you have probably experienced while singing in the shower. To arrive at the atomic mass presented in the periodic table, first multiply the mass of each
naturally occurring isotope of an element by the fraction of its abundance and then add up all the fractions. What is the importance to people of learning nature's rules? CHAPTER 8 S TAT I C A N D CU R R E N T E L E C T R I CI T Y 191 CHECKPOINT 1. T H I N K A N D S O L V E (M AT H E M AT I C A L A P P L I C AT I O N) 40. The image in (a) is
an infrared view of the collision, which produced much heat as well as visible scars (the black dots), as shown in the photograph in (b). The digestion and drugs more polar. To reduce the amount of these pollutants entering the atmosphere, most automobiles are
equipped with catalytic converters, as shown in Figure 17.15. VIDEO: Forces and Interaction F I G U R E 2 .1 5 He can hit the massive bag with considerable force. Other systems that can be described by conceptual models are the economy, population growth, the spread of diseases, and team sports. Whenever a physical system is allowed to spread
its energy freely, it always does so in a manner such that entropy increases, while the energy of the system available for doing work decreases. There is no need for you to learn all its rules. As an air mass moves down the leeward slope, it
warms. How does an ion differ from an atom? Within a neutral molecule, how many covalent bonds does an oxygen atom form? Base your reasoning not on memorization but rather on what you know about electrical attractions between molecules and the various physical properties of gasoline and motor oil. The original distance was 5 mm, which
stretched to 50 mm. But because the cloud cover is so intense, a Venusian sunrise or sunset is never visible from its surface. The caffeine in coffee and tea exists in the form of the tannin salt, which is why coffee and tea are more effectively brewed in hot water. Worse still are claims of bottled water that contains "functional" water in which the
structure of water has been modified using "subtle energy" to make it more nutritious. (Hint: Consider Appendix A.) 62. (b) The PE of a charged particle held in an electric field. Which water should be hot and which cold? Figure 3.34 shows how you can perform this in the lab or at home: Place two wires that are connected to the terminals of an
ordinary battery into a glass of salted water. On a chilly day, however, the chemical reactions proceed at a lower rate, and, as a consequence, the alligator's movements are unavoidably sluggish. Only later, in the light of newfound discoveries, did the scientific community accept Wegener's concept. FIGURE 9.24 INTERACTIVE FIGURE When a
magnet is plunged into a coil with twice as many loops as another, twice as much voltage is induced. Because red, orange, and yellow light are the least scattered by the atmosphere, light of these low frequencies is better transmitted through the air. This is your blind spot. And as we hope you will discover, learning continues throughout one's life. In
Henry's electrical experiments, his wife donated part of her wedding gown for silk to cover the wires of Henry's electromagnets. (This loose coupling can be very important for braking as well.) 113. d2 (0.1 m)2 37. The Sun is somewhere in the middle of the luminosity range. The cause of this mass extinction is uncertain, but scientists have recently
demonstrated how this extinction may have been initiated by an intense burst of gamma rays produced by the explosion of a nearby star. Does the northward-pointing needle point northward when the compass is brought to the Southern Hemisphere? As was discussed in the prologue of this textbook, theories are not carved in stone. If you're about to
catch a fast baseball with your bare hand, you extend your hand forward so you'll have plenty of room to let your hand move backward after you make contact with the ball. Slow-moving H2O molecules condense upon collision. When can a solution of a weak base be more corrosive than a solution of a strong base? Because of surface tension, the ball
is pulled beneath the surface as the can falls. When electrons are gained, electrons outnumber protons and the ion has a negative net charge. Can you see that this occurs when the cannon is horizontal? (In the quantum world of atoms and photons, the rules are different.) 252 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Relate the compression
and extension of waves due to motion to the Doppler effect. Yes, by centripetal acceleration as occurs in a rotating system. Inclusions Any inclusions (pieces of one rock type contained within another) is older than the rock containing it. C H A P T E R 19 19.7 Polymers EXPLAIN THIS 507 O R G A N I C CO M P O U N D S LEARNING OBJECTIVE
Describe how polymers are synthesized from monomers. There is a lower ratio of hydrogen atoms in the acetaldehyde product, so the grain alcohol is oxidized. The reactor will house electrically charged hydrogen gas (plasma) heated to more than 100 million ;;;;C, which is hotter than the center of the Sun. Precipitation also occurs indirectly when
water-dwelling organisms take up dissolved constituents and use them to build shells or hard body parts or to perform other life processes in which solids are created and then discharged into the surrounding water. Many elliptical galaxies are thought to be former starburst galaxies because of their low abundance of interstellar dust and gases. The
frequency of a vibrating pendulum, or of an object on a spring, specifies the number of to-and-fro vibrations it makes in a given time (usually in 1 s). 18.7 Electrolysis EXPLAIN THIS How might electrolysis be used to raise a sunken ship? 534 PARTHS CIEN CEFIGURE ARTHS CIEN CEFIGURE AR
and sometimes shell fragments and/or solid organic matter. But more important, the condensation rate exceeds the evaporation rate above the lifting condensation level—cloud droplets begin to form. What reverses in reverse osmosis? In the next C H A P T E R 13 T H E ATO M I C N U CL EU S A N D R A D I OAC T I V I T Y 1620 years, half of the
remaining radium will decay, leaving only 1 kg one-fourth the original amount of radium. Explain your answer. It breaks apart into sheets. If fired with a low horizontal speed, a cannonball would follow a curved path and soon hit Earth below. What determines whether an object will float or sink in water? The only difference between the rock sale
applied to roads in winter and the substance you sprinkle on popcorn is the size of the crystals. This is because when the boulder is submerged, the water exerts an upward force on it—opposite in direction to gravity. Solution: The heat gained by the cooler water equals the heat lost by the warmer water. Hewitt 738: NASA 740: Rick
Whitacre/Shutterstock P-3 742: NASA/Jet Propulsion Laboratory 746: NASA 748: (top) P. This increased amount of impulse is the same that your head supplies if the flowerpot bounces from it. We see that the direction of force is changed: if we push down, the load is lifted up. In terms of the human body, what people believe will happen often can
happen because of the physical connection between the mind and body. The probability of eventual death is 100%. How does this fact relate to what you know about the organization of the periodic table? LEARNING OBJECTIVE Show how electrons behave as though they are arranged in a series of shells centered around the atomic nucleus. As
depicted in Figure 12.19, are gallium atoms really red and arsenic atoms green? 4.7 Circular Satellite Orbits Why does kinetic energy and momentum remain constant for a satellite in a circular orbit? A copolymer is a polymer composed of two or more different monomers. F I G U R E 6 .1 5 F I G U R E 6 .1 6 One end of the bridge rides on rockers to
allow for thermal expansion. In one design, hydrogen is generated within the fuel cell from chemical reactions involving liquid fuels, such as methanol, CH3OH. 452 PA R T T W O CH E M I S T RY 77. If Earth spins slower, day length increases. (b) Now let's think about the partial melting of real rocks: What melts? Add a couple capfuls of 3% hydrogen
peroxide and watch oxygen bubbles form. 2 9 (a) (b) (a) The Large Magellanic Cloud and (b) the neighboring Small Magellanic Cloud are a pair of irregular galaxies. A single organic molecule, therefore, might be classified as both a phenol and an ether. 234 PA R T O N E P H Y S I CS 44. At the same time, however, because of the lower energy of
 activation for these reactions, ozone molecules are rapidly converted to oxygen molecules. Elements of group 17 are known as the halogens ("salt-forming" in Greek) because of their tendency to form various salts. FIGURE 10.22 FIGURE 10.23 Constructive (top two panels) and destructive (bottom two panels) wave interference in transverse and
longitudinal waves. 10.3 Transverse and Longitudinal Waves 7. Therefore, the frequency of wave motion is the same at points A and B, or anywhere in the vicinity of the bug. An object's size, however, is not necessarily a good way to judge its mass. What does this indicate about their relative positions in the periodic table? Because there is 50 times
the area, 50 times as much force is exerted on the larger piston. Money in the bank may grow at 4 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at about 7 percent per year; electric power generating capacity in the United States grew at a percent per year.
before meeting up with oxygen at the oxygen-facing electrode (the cathode). 762 PA R T F O U R ASTRONOMY F I G U R E 2 7. Computing Velocity and Distance Traveled on an Inclined Plane ecall from Chapter 1 Galileo's experiments with inclined planes. Thus, the pH decreases and yet the solution remains neutral because the hydronium- and
hydroxide-ion concentrations are still equal. You're in a car traveling at some specified speed limit. You push harder—say, 55 N—and the desk still doesn't slide. The voltage source provides a total current Itotal to the circuit and "sees" a total equivalent resistance of Req in the circuit. Small wonder that the language of the dolphin is very unlike our
own! FIGURING PHYSICAL SCIENCE SAM PLE PROBLEM 2 Problem Solving While sitting on the dock of the bay, Otis notices incoming waves with distance d between crests. If the air is stable, a layer of stratus clouds may form. Because it was important that no static charge build up on the powder on their bodies as they ran to and fro. Similarly,
the Andromeda galaxy we see today is the Andromeda galaxy as it appeared 2.5 million years ago. Specific heat capacity The quantity of heat required to raise the temperature of a unit mass of a substance by 1°C. Aha! Cool! (where air pressure is greater than at higher elevations), and it becomes much warmer. When, and how often, is the Moon
absent from the night sky? 13. Galileo demolished the idea that heavy things fall faster than lighter things in his famous Leaning Tower of Pisa experiment, where he allegedly dropped objects of different weights and showed that—except for the effects of air resistance—they fell to the ground together. (d) appears to be very old. The bubbles that form
contain hydrogen gas produced as the water decomposes. (force * distance) input = (force * distance) output force * output distance = output force * output distance. If you begin in step, when will you and your friend again be in step? It is in equilibrium. To get a "feel"
for what's happening here, add about a tablespoon of tiny beads to a large balloon (pellets, beans, BBs, or grains of rice also work). This heat melts the ice. You're explaining to a youngster at the seashore why the water is cyan colored. Radioactive isotopes used to trace such pathways are called tracers. 2 6 The giant elliptical galaxy M87, one of the
most luminous galaxies in the sky, is located near the center of the Virgo cluster, some 50 million light-years from Earth. EXPLAIN THIS VIDEO: How a Thermostat Works s the temperature of a substance increases, its molecules jiggle faster and move farther apart. A key factor needed for precipitation to occur is (a) updraft motion in relatively thick
clouds. When the plague subsided, Newton returned to Cambridge and soon established a reputation for himself as a first-rate mathematician. What is the class average? FIGURE 10.46 Does each listener hear the same music? No, radiation curves hold for a giant star as for any other radiating body. Is your friend correct? Rhyolite comes in several
different forms (Figure 20.21). 48. For any exothermic reaction, energy can be considered a product and is thus sometimes included after the arrow of the chemical equation: 2 H2 + O2 h 2 H2O + energy in the reactant molecules. If
a proton at a particular distance from a charged particle is repelled with a given force, by how much does the force decrease when the proton is three times as distant from the most important concepts in each chapter. When the buoyant
and gravitational forces are in balance, the vertical position of the crust is stable. Twenty-four hours later, the entire solution is red even though no one stirred the water. At a steady inflation rate of 7 percent, what will be the price every 10 years for the next 50 years for a theater ticket that now costs $30? Compressing a gas requires energy,
however—and, as a consequence, the inherent efficiency of the fuel cell is lost. (c) not well understood. Volume The quantity of space an object occupies. 26.4 The Outer Planets 16. Rank the following in order from the most energy released to the least energy released: (a) uranium-235 splitting into two equal fragments, (b) uranium-235 splitting into
capacity and poor ability to conduct heat, the bottom of deep bodies of water in cold regions remains at a constant 4°C year round. The gurgling is due to air entering the jar. Ideally, a system would be developed that produces hydrogen using the energy of direct sunlight. (d) all of the above 10. The "liquid" is now roughly 47% red and 53% black. But
the effects of these equal forces are very different. The success of science rests more on an attitude common to scientists than on a particular method. Other Discussion Questions allow students to present their educated opinions on a number of science related hot topics, such as the appearance of pharmaceuticals in drinking water or whether it
would be a good idea to enhance the ocean's ability to absorb carbon dioxide by adding powdered iron. A 1-kg object weighs nearly 10 N on Earth. The net energy of the reaction is found by adding the two quantities: Net energy of the reaction is found by adding the two quantities. Net energy of the reaction is found by adding the two quantities.
indicates that there is a net release of energy, and so the reaction is exothermic. With greater warmth, more of Venus's water F I G U R E 2 6 .1 0 Venus is an Earth-sized planet barren of any oceans. Show that 5000 cal is required to increase the temperature of 50 g water from 0°C to 100°C. EXPONENTIAL GROW TH AND DOUBLING TIME A-13 F I
when your car windshield fogs up, make sure the air conditioner is on when in defrost mode, even when blowing heated air. By virtue of its elevated position, the water behind a dam has energy that may be used to power a generating plant below, where it is transformed to electric energy. The strong man is pulled in the three situations shown. When
hot water is added, much of the original flavor of the coffee is preserved. The absence of all color is black. Hold the Ping-Pong ball with your arm stretched out toward where the Moon is so that the ball overlaps the Moon. During this time, the Chinese and Polynesians were charting the stars and the planets. Chemical property Any property that
breathe when snorkeling at a depth of 1 m, and practically impossible at a depth of 2 m? FYI F I G U R E 2 7.1 9 A rendering of a black hole stealing matter from a companion star. Doesn't this make sense? (c) increased temperatures. A voltage across a non-infinite resistor will produce current in accord with Ohm's law. About 30 million years ago
when the westward-moving North American Plate collided with the Pacific Ridge system (when the San Andreas fault formed), Baja California tore away from the Mexican mainland, forming the Gulf of California tore away from the Mexican mainland, forming the Gulf of California.
should elicit much discussion! What does an air conditioner have in common with a refrigerator? So it is safe to say that tomorrow's weather will probably be very similar to today's weather will probably be very similar to today's weather will probably be very similar to today's weather. Mastering Physics also helps you to identify and report results by learning outcomes, or specific measurable goals often used by institutions to assess student
progress. The climate would be reversed also in Washington, DC, and produce a warmer climate in winter in that region. Some wear special wristbands that are connected to a grounded surface so that static charges do not build up—when moving a chair, for
example. Or both? The unit of power is the joule per second, called the watt. How might this fact assist a tree in moving water upward from its roots? VIDEO: Oersted's Discovery N Does every magnet necessarily have a north and a south pole? The lowest energy level has a principal quantum number n = 1. The air a scuba diver breathes is
pressurized to counteract the pressure exerted by the water surrounding the diver's body. (Be careful not to do this when acceleration is not uniform!) So if we add the initial speed (zero in this case) and the final speed of 2 m/s and then divide by 2, we get 1 m/s for the average velocity. Galaxies, for example, show a redshift in the light they emit as
they move away from us in the expanding universe. Ken's pull on the rope is transmitted to Joanne, causing her to accelerate toward him. (What can't happen in a low-mass accumulation of hydrogen atoms and other interstellar material?) 69. As it happens, the water in the bucket is falling, but with less speed than you give to the bucket. (b) Because
HCl is a strong acid, nearly all of its molecules break apart in water, giving a high concentration of ions, which can conduct an electric current that lights the bulb. Rank the light that enters your eye from a distance of 2 m, and (c) one
the infinite number of hues that make up the color spectrum of the rainbow. What is the fate of the energy in ultraviolet light incident on glass? She is midway between the back and front sides. At the front, air gradually warms, and the rain or snow turns to drizzle. Thus, the melting point of ice is 273 K, and the boiling point of water is 373 K. He is
remembered scientifically for hydraulics, which changed the technological landscape more than he imagined. The Magellanic Clouds are our closest galactic neighbors, about 150,000 light-years distant. EXPLAIN THIS I f a projectile just above the drag of the atmosphere is given a horizontal speed somewhat greater than 8 km/s, it overshoots a
circular path and traces an oval path called an ellipse. Airflow originates near the surface The conveyor-belt model of but undergoes frontal lifting when it encounters the warm front. The second coil is connected to a galvanometer. This force pair constitutes a single interaction. FYI F I G U R E 2 1 .11 Alfred Wegener (1880–1930) was a brilliant
interdisciplinary scientist. (Algebraic manipulation of the formulas P = IV and I = R 2 V leads to P = .) 107. Valence electrons are located in the outermost occupied shell of an atom. Rank the following hydrocarbons in order of increasing number of hydrogen atoms: OH (a) (b) (c) C H A P T E R 19 32. But because of an effect called lateral inhibition
we don't perceive the actual differences in brightness. Q = cm@T + mLv = (1 cal/g # °C)(15 g)(100°C - 20°C) + (15 g)(540 cal/g) = 9300 cal. Initially, the additional heat from the Sun will increase the rate at which Earth's oceans evaporate. Why, then, don't all objects float like this balloon? The nucleus of an electrically neutral iron atom contains 26
protons. This small magnitude indicates an extremely weak force. Additional thrust is obtained by a pair of solid-fuel rocket boosters containing a mixture of ammonium perchlorate, NH4ClO4, and powdered aluminum. Near sunset (or sunrise) they are visible as "evening stars" or "morning stars" or "m
size and weak gravitational field, it holds very little atmosphere. For large nuclei, more neutrons than protons are needed. (f) A = B = C = D. This will be the Moon. Ohm's law makes good sense. (Density is mass/volume, as we'll discuss in Chapter 5.) Iron is much more dense than bananas, so 2 kg of iron must occupy less volume than 1 kg of
bananas. The data and subsequent interpretations are open to scrutiny in a social environment where it's okay to have been dishonest or deceiving. CHAPTER 1 1.7 PAT T E R N S O F M OT I O N A N D E Q U I L I B R I U M Dynamic Equilibrium EXPLAIN THIS How does a sliding air puck move while no
net force acts? If so, in what direction? Using Newton's second law, we find that F 2000 N = m 1000 kg 4000 N F =
push outward on the balloon. (a) Show that the height necessary for this to occur is at least 34 km. So that's half, or 50%. (b) Earth's early formation. The vibration that begins with the fundamental vibrating frequency is the first harmonic, twice the fundamental is the second harmonic, and so on in sequence. Use a dry wooden stick or some other
nonconductor so that you don't get electrocuted yourself. Complementary colors Any two colors that, when mixed, produce white light. When viewed from the North Pole, it appears more parallel to the horizon. Hewitt, Leslie A. Sulfates and halides are nonmetallic mineral resources. Wood is a good insulator even when it's red hot. Which is less
damaging: plugging a 110-V appliance into a 220-V circuit or plugging a 220-V appliance into a 110-V circuit? Suppose an investigator places both a free electron and then a free proton into an electric field between oppositely charged conducting plates. To hear yourself more clearly, use a flexible plastic tube and twist the outer end toward your ear
Is the acceleration there zero also? Most Kuiper belt objects never make this journey and instead remain perpetually frozen within the outer reaches of our solar system. E LEC TRO N ICS TEC H N OLOGY A N D SPA RK S Electric charge can be dangerous. Shake the mixture a few times to allow the materials to settle. The shaded area under this
curve represents the total supply of the resource. Return half of the warm water to the glass and stir to dissolve all the sugar. However, the elements used to make dietary supplements ultimately come from the naturally occurring minerals of Earth's crust. (b) halves. The scheme violates both the first and second laws of thermodynamics. If the freigh
cars F I G U R E 3 .1 3 are of equal mass and are coupled by the collision, can we INTERACTIVE FIGURE predict the velocity of the coupled cars after impact? What is the fate of the half brought to rest? Rock An aggregate of minerals. The type of magma formed depends on the type of rocks and minerals that melt. Hours later, our planet is
completely molten and rotating very rapidly. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Chemical sediments that form by the precipitation of minerals from water on Earth's surface. Add nothing to the third cup so that it remains blue. Molecule The fundamental unit
of a chemical compound, which is a group of atoms held tightly together by covalent bonds. What physical properties are used to identify minerals? This beginning point from which all matter and energy within our universe arose is referred to as the Big Bang. This force pair is fairly large. 9 Escape Speed C enturies before Newton's discovery,
Aristotle and others believed that all heavenly bodies move in divine circles, requiring no explanation. The prefix "nimbo" means rain, so nimbostratus clouds are a wet-looking cloud layer associated with light to moderate rain or snow. Both English physicist Michael Faraday and American physicist Joseph Henry independently discovered
electromagnetic induction at about the same time. The resulting "lift" (red arrow) causes the ball to curve (blue arrow). Also, metals are opaque and shiny because the free electrons easily vibrate to the oscillations of any light falling on them, reflecting most of it. A "foreign" substance in water lowers its freezing point (it must be colder to freeze)
Einstein first believed, as most people did during his time, that the universe was static. The Orion Nebula, like the nebula from which our solar system formed, is an interstellar cloud of gas and dust and the birthplace of stars. Elements of group 2 also form alkaline solutions when mixed with water. (c) the zoned sequences of minerals. Use
conservation of energy to show that the speed of the banana just before hitting the water is v = 22gh. CHAPTER 28 28.1 T H E S T R U C T U R E O F S PACE A N D T I M E Looking Back in Time EXPLAIN THIS What three major lines of evidence that
support it. Figure 27.4 shows the diurnal motion of the stars making up the Big Dipper. Stand one dominos, which also each hit two other upright dominos, which also each hit two other upright dominos, which also each hit two other upright dominos, and so forth. Now hold the flame of a candle in the cloud of condensed steam. So the cooler, denser air acts as a wedge where
lifting takes place. The combination of the cores of the two galaxies would most likely result in an active galactic nucleus. Series Circuits Switch Voltage source FIGURE 8.29 INTERACTIVE FIGURE A simple series circuit. A hydrogen isotope with one proton and two C
or distance? But where does magma come from? Refraction. So you should probably carry an umbrella. Why isn't Millie's hand burned when she holds it above the escape valve of the pressure cooker (see Figure 7.8)? Natural causes are volcanism, glaciation, variations in sea level (also changes in oxygen or salinity), and global climate change. If the
Moon's tangential velocity were zero, it would fall straight down and crash into Earth! 2. When the frequency of forced vibrations on an object matches the object's natural frequency, a dramatic increase in amplitude occurs. As a nebula contracts and spins faster, it flattens out into a disk. Amines are typically less soluble in water than are alcohols
because the nitrogen- hydrogen bond is not quite as polar as the oxygen-hydrogen bond. The force is strongest when the current is perpendicular to the magnetic field lines. 52 PA R T O N E P H Y S I CS FIGURE 2.29 We see Newton's third law in action everywhere. (b) FIGURE 8.7 (a) The center of the negative "cloud" of electrons coincides with
the center of the positive nucleus in an atom. A point on the perimeter of a merry-go-round or turntable moves a greater distance in one complete rotation FIGURE A.4 When a phonograph record turns, a ladybug farther from the center travels a longer path in the same time and has a greater tangential speed. (b) High-silica minerals melt; low-silica
minerals do not melt. Ryan Patterson resonates on page 247. Such metals are chemically happier "hiding out" with the water until they are so concentrated that they can form their own minerals—such as gold ore. Cenozoic—age of mammals, diversification of mammals, expansion of flora, emergence of humans; extinction of many large mammals
What idea of Aristotle did Galileo discredit with his inclined-plane experiments? What molecule loses a proton to form the hydroxide ion, OH - ? FIGURE 18.26 As of 2010, more than 1.2 million Prius hybrids had been sold worldwide, about 266,000 of them in the United States. We can see in Figure 15.42 that the number of induced dipole-induced
dipole attractions between two methane molecules is appreciably less than the number between two octane molecules. C H A P T E R 11 LIGHT 283 F I G U R E 11. When we study nuclear physics, we'll see that these and other conservation laws rule in the submicroscopic world. Were you really speeding away from him, or was the space between the
two of you simply expanding? As a result, more than 400 people in the world (mostly children) die every hour from preventable diseases or infections such as cholera, typhoid fever, dysentery, and hepatitis, which they contract by drinking contaminated water. Look at Figure 21.33; can you see how compression shortens the crust? A rule of thumb for
estimating the distance in kilometers between an observer and a lightning stroke is to divide the number of seconds in the interval between that draws 8 amperes, and a lamp that draws 2 amperes. The remaining melt becomes depleted in the
constituents of minerals that have crystallized and enriched in the constituents of minerals that are yet to crystallize. 9.5 Magnetic Forces on Moving Charges 12. Brass expands more when heated than iron does, and it contracts more when cooled. Silicate A mineral that contains both silicon and oxygen and (usually) other elements in its chemical
composition; silicates are the largest and most common rock-forming mineral group. (Tracy's wedding ring is figured prominently on page 348.) Sister Joan is riding her horse on page 25. Lethal damage occurs because many cellular mechanisms continue to operate even at very low oxygen levels. On the other hand, Proxima Centauri is quite dim,
with a luminosity of 0.00006 LSun. Why isn't it possible for a scanning probe microscope to make images of the inside of an atom? (c) Uniform lines of force between two oppositely charged parallel plates. Why do we find folded and fractured rock layers in zones of regional metamorphism? If 4 half-lives equals 8 h, then a single half-life equals 8/4 = 2
h. As in a very slow magnetic tape recording, the magnetic history of Earth is recorded in the spreading ocean floors. As a consequence, dipole-induced dipole attractions are weaker than dipole-dipole attractions. Basalt is the most common igneous rock on the ocean floor. Moldable wet clay, for example, was found to harden to ceramic when heated
by fire. 554 PARTTHREEEARTHSCIENCEREADINES ASSURANCETEST (RAT) If you have a good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. CHAPTER 8 89. Either pole of a magnet will induce alignment of domains in the paper clip: Attraction results because the
pole of the aligned domains closest to the magnet's pole is always the opposite pole. By utilizing Planck's quantum hypothesis, Bohr's model solved the mystery of atomic spectra. In the early 1800s, geologists met with violent condemnation because they differed with the account of creation in the book of Genesis. On a warm day, the chemical
reactions occurring in an alligator are "up to speed," and the animal is more active. 21. Then, d = vt = 1530 m/s * 1 s = 1530 m/s * 1 s = 1530 m = 0.5 1 1s 2 (1.8 m) = 0.9 m/s. If the equally massive railroad cars of the preceding question couple together after colliding inelastically, how does their speed after the collision compare with the initial speed of car A? Force
is proportional to the inverse square of this distance. The year was 1906. Which of the numbered cards can she see reflected in the mirror? This 10 m/s gain each second is the boulder's acceleration. Each type of mineral has a unique composition and crystal form (Figure 20.6). A dehumidifier with a resistance of 20 \( \frac{1}{2} \) draws 6.0 A when connected to
an electrical outlet. So a magnitude-6 earthquake shakes the ground 10 times more than a magnitude-5 earthquake but 100 times more than a magnitude-6 earthquake but 100 times more than a magnitude-7 earthquake but 100 times more than a magnitude-8 earthquake but 100 times more than a magnitude-9 earthquake but 100 times more than a magnitude-8 earthquake but 100 times more than a magnitude-9 earthquake but 100 times more than a magnitude-8 earthquake but 100 times more than a magnitude-9 earthquake but 100 times more than
the electric potential would be the same. The result would be a bit of clumpiness. Reduction occurs at the cathode (remember that a carbon dioxide molecule is more than twice as massive as a water molecule. If a typical atom were expanded to a diameter of 3 km, about as big
as a medium-sized airport, the nucleus would be about the size of a basketball. Diffuse reflection. Te. .. The product of aluminum oxide, Al2O3, which is not water soluble. 394 PA R T T W O CH E M I S T RY 72. In what direction relative to a magnetic field does a charged particle move in order to experience maximum deflecting
Fiberglass is a good insulator, many times better than glass, because of the air that is trapped among its fibers. They then separate from one another, forming a gas. As the heat from the inner thermonuclear reactions begins to die down, gravity predominates and the star shrinks. And then there is nothing. What happens with each bounce? Which
cloud type is a better warmer and which is a better cooler: high, thin cirrus clouds or low, thick stratus clouds? * For rotating about its own axis—the concept of rotational inertia must be introduced. Waves encounter point A as frequently as they encounter point B.
relative to something else. Air pressure doesn't allow the water out until some air has pushed its way up inside the bottle to occupy the space above the liquid. This decreased resistance is accompanied by an increased current, the same increased current, the same increased resistance is accompanied by an increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an increased current, the same increased resistance is accompanied by an inc
encounter glass that isn't transparent to them. (c) have an evaporation rate equal to its condensation rate. In doing so, you are judging which is the more resistant to a change in motion. Now we see mass as a measure of gravitational force, which in this context is called gravitational mass.
Incoming waves gain on leading slower waves, and the distance between waves decreases. 2 Cosmic Inflation 28. Physical change in its chemical identity. Move aside all the coins that landed tails-up. If your mass is 80 kg, show that your acceleration is 0.5 m/s2. A toms are so small
that the number of them in a baseball is roughly equal to the number of Ping-Pong balls that could fit inside a hollow sphere as big as Earth, as Figure 12.17 illustrates. So, either the magnetic poles had migrated through time or the continents had drifted. The U.S. remained with 110 V (today, it is officially 120 V) In the early days of electrical
lighting, high voltages burned out electric light filaments, so low voltages were more practical. A-7 A PPE N DI X B Vectors Vectors and Scalars Direction as well. A quasar releases its energy from its active galactic
nucleus. All bulbs are identical in the circuits shown. More important than being an expert at balancing equations is knowing why they need to be balanced. FIGURE 3.7 Cassy imparts a large impulse to the bricks in a short time and produces a considerable force. Carbon dioxide is being produced faster than the ocean can absorb it, and this may
alter Earth's environment. Later on, seafloor spreading was confirmed by the magnetic reversal recorded in the seafloor. The other component, f 🐟, changes the direction of the satellite's motion and pulls it away from its tendency to go in a straight line. Both speed and frontal area affect the force of air resistance on a falling object. Because of the
poor conductivity of the coals, energy from within the coals does not readily replace the energy that transfers to your feet. Spring tides are the lowest tides as well as the highest tides are the lowest tides as well as the highest tides. Thus, when you are calculating the net energy released or absorbed during a reaction, you'll need to be careful about plus and minus signs. Exothermic Description of
a chemical reaction in which there is a net release of energy. While you are airborne, no amount of leg or arm pumping or other bodily motions can change your hang time. Developed countries have the technology and infrastructure to produce vast quantities of water suitable for drinking; as a result, many citizens take their drinking water for
granted. nothing to do with planets. Where did the atoms that make up a newborn baby originate? State Newton's law of universal gravitation in words. Clouds form as the water vapor condenses into tiny droplets. The Empire State Building is struck by lightning about 25 times every year. Consider a satellite in a circular orbit above Earth's surface
Because of this positioning, we can deduce that germanium has more metallic properties than silicon, Si (atomic number 14) and is a slightly better conductor of electricity. Second, they must have sufficient kinetic energy to initiate the breaking of chemical bonds so that new bonds can form. Although the inner core is indeed very hot, intense
pressure from the weight of the rest of Earth prevents the inner core C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R from melting (just as a pressure cooker prevents high-temperature water from boiling, as discussed in Chapter 7). How do the input and output parts of a generator and a motor compare? Contrails can
be used to help predict the weather—if a contrail does not form, or if it disappears quickly, fair weather will continue. Very big particles, like droplets of water, absorb more radiation than they scatter. Furthermore, just as your muscles become stronger with extra mental exercise.
What are some examples of alkaloids? For a wave, the number of crests that pass a particular point per unit time. The total, 140 cal + 80 cal + 100 cal = 320 cal. For the formation of water shown above, we see that the element oxygen is gaining electrons that the element oxygen is gaining hydrogen atoms, which means that the oxygen is gaining electrons to the formation of water shown above, we see that the element oxygen is gaining electrons that the element oxygen is gaining hydrogen atoms, which means that the oxygen is gaining electrons to the formation of water shown above, we see that the element oxygen is gaining hydrogen atoms, which means that the oxygen is gaining hydrogen atoms, which means that the oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the formation of water shown above, we see that the oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the formation of water shown above, we see that the element oxygen is gaining electrons at the element oxygen is gaining element oxygen is gaining element oxygen is gaining element oxygen is gai
from the hydrogen, which is why the oxygen atom within water is slightly negative as discussed in Section 15.7. The three ways of identifying a reaction as an oxidation-reduction type of reaction are summarized in Figure 18.20. This can be seen on a guitar, where the most massive string has the lowest natural pitch. s we learned in Chapter 10,
waves can be either longitudinal or transverse. What is evaporation, and why is it a cooling process? No particular mass is specified, so we'll work with quantity of heat/mass (for our answer should be the same for a small chunk of rock or a huge chunk). This granite is an aggregate of minerals—the minerals feldspar, quartz, and hornblende. Perhaps
they have little science background and may be mathematically challenged. Pressure depends on depth, not volume. An adiabatic process has occurred when (a) air is warmed by solar radiation. We find that it is more difficult to push the magnet into a coil made up of more loops. Hewitt 411: Sheila Terry/Photo Researchers, Inc. Clouds having vertical
development Altostratus Altocumulus Cumulus Cu
relative masses? 26.3 The Inner Planets 11. A few of these objects occasionally fall toward and then around the Sun, where they appear as comets. The speed of light slows when the light is refracted in a medium. He decided to call the glass positively charged, which means that the silk ended up with a negative charge because it lost electric fluid to
the glass. Interestingly, currents in the same direction attract, and currents in opposite directions repel. If you push on a wall with your fingers, more is happening than you pushing on the wall. This chemical process was expensive. The same thing happens with the Moon. In other words, it will have the same physical and chemical process was expensive.
also have the same biological effects, if any. The light paths are reversible for both reflection and refraction. Furthermore, the halogentungsten combination splits apart when it touches the hot filament, returning halogen as a gas while restoring the filament by depositing tungsten back onto it. (b) Calcium carbonate) has perfect cleavage in
three directions (though not at right angles, like a cube). This straight line, which is a cross-section of our solar system, always intersects with the Sun and often with the position of our Moon. Cornea Retina Lens Fovea Blind spot Iris left eye, and look at the round dot and the X to its right with your right eye only. Does this mean that the Moon
doesn't spin about its axis as Earth does daily? If we were watching these energy-concentrating events on video, we would quickly conclude that the video was running backward. Batholiths are created by numerous intrusive events over millions of years—they form the cores of many major mountain systems around the world. LEARNING OBJECTIVE
Describe why the speed of a satellite changes in an elliptical orbit. Use a little laundry bleach on the mug, and brush your teeth with baking soda. As you shake the balloon wildly, the flying beads represent the gaseous phase. This model is similar to Bohr's planetary model in that it shows electrons restricted to particular distances from the nucleus. E
LEARNING OBJECTIVE Recognize where exidation and reduction occur in a device that generates electricity. See also Phase changes buoyancy in, 133-134 pressure in, 127-128 solubility of, 408-409 General theory of relativity, 777-781 Generators, 228-229 Geologic time scale, 620, 626-641. If the number of turns of wire in both coils is the same,
voltage input and voltage output are the same. Which depends on location: weight or mass? Name the cloud form associated with (a) the hazy shade of winter, (b) a mackerel sky, (c) floating cotton, and (d) snowfall. Hewitt/Paul G. (d) the universe is symmetrical and harmonious.
sample is being heated and the material is melting. The center of the outer wave originated when the bug was at the center of that circle. REVIEW 117 111. Total energy = PE + KE = 5000 MJ + 4500 MJ = 9500 MJ. Satellite motion was understood by Isaac Newton, who reasoned that the Moon was simply a projectile circling Earth under the
attraction of gravity. When two dipoles are equal and opposite, they effectively cancel each other out. Once on the surface, this water would evaporate, freeze, and sublime away. 9.4 Electric Currents and Magnetic Fields 8. When walking, you interact with the floor. This relationship between energy and mass is the key to understanding why and how
energy is released in nuclear reactions. The equivalent resistance of a pair of resistors depends on how they're connected, a, c, b (the greater the difference in electronegativity between bonded atoms, the greater the polarity of the bond). The acceleration produced by a net force on an object is directly proportional to the net force, is in the same
direction as the net force, and is inversely proportional to the mass of the object. Instead, the beam consists of zillions of small, discrete packets of Elements heated by a flame glow their characteristic color. This bending may be used to turn a pointer, regulate a valve, or close a switch. The calculator finds the power to which 10 is raised to give the
number. If the contrail remains for a long time, a change in the weather may be expected. Upon shrinking, matter becomes compressed, which is an additional source of heat to ignite further nuclear fusion. This work is the friction force acts. Dark matter has mass and
therefore has the effect of curving spacetime, which we perceive as gravity. Smash a large cubic sodium chloride crystal with a hammer, and what do you get? Matter is anything that occupies space. Would the resulting smell of the alcohol be more or less noticeable if the tabletop were much warmer? Fuel cells also produce the chemical products of
electricity-generating chemical reactions. So, constant velocity means motion in a straight line at constant speed—motion with no acceleration. Today, most distilling plants heat the water by burning large quantities of fossil fuels, which, unfortunately, generates excessive levels of pollution relative to the volume of fresh water produced. sample is
incredibly large. In place of sucrose crystals and water, we have a homogeneous mixture of sucrose molecules in water. The count of elements in the sixth period goes from lanthanum (La, 57) to cerium (Ce, 58) on through to lutetium (Lu, 71) and then back to hafnium (Hf, 72). If the tack is placed into the water, thermal energy doesn't flow from the
warm water to the tack. Barium ions carry a 2+ charge, and nitrogen ions carry a 3- charge, which is another way of saying it has gained electrons and has thus been reduced. If the universe stopped expanding at this very
moment, the cosmological redshift of distant galaxies would (a) promptly disappear. Carbonates have many uses—buildings are often made from quarried limestone, and carbonates are used to make cement. 1-6 May 1-10 Jul. (The force of the Moon's gravity is about 16 of the weight the rock would have on Earth; the force of Earth's gravity at that 1
distance is only about 3600 of the rock's Earth-weight.) 99. Pressure along the streamlines is reduced where they are closer together. This is desirable, for it enables us to see this page and other objects from any direction or position. For years, marine scientists were mystified by sound waves detected by underwater microphones in the Pacific
Ocean. Some colors, like the blue of the sky, are the result of selective scattering.* Consider the analogous case of sound: If a beam of a particular frequency, the tuning fork is set into vibration and redirects the beam in multiple directions. Similarly, the planets continuously fall around the
Sun in closed paths. Why does a heavy parachutist fall faster than a lighter parachutist who wears the same size parachutist fall faster than a lighter parachutist fall faster than a lighter parachutist who wears the same size parachutist who wears the same size parachutist fall faster than a lighter parachutist fall faster than a lighter parachutist who wears the same size parachutist fall faster than a lighter parachutist who wears the same size parachutist fall faster than a lighter parachu
Before the discovery of dark energy and dark matter, astronomers had calculated that the expansion. A common unit of concentration used by chemists is molarity, which is the solution's concentration expressed in moles of solute per liter of solution: Molarity = number of
moles of solute/liters of solution A solution A solution that contains 1 mole of solute per liter of solution, which is often abbreviated 1 M. (a) Melting point decreases as silica percentage increases, through which Earth will be subject to the
fate of Venus, where it is forever cloudy. When it is desirable to reduce the radiant energy coming into a greenhouse, as in the summer, whitewash is applied to the glass simply to reflect much of the incoming sunlight. Rank the compounds in order of increasing numbers of atoms: (a) C12H22O12, (b) DNA, (c) Pb(C2H3O2)2. The geosphere is made up
of rocks, and rocks are made up of minerals. ** This is derived from the definitions of pressure and density. The light that emerges has speed c. Anything in mechanical equilibrium doesn't accelerate—neither linearly nor rotationally. Why do clouds tend to form above mountain peaks? Show that: (a) 60 V ac is available at the secondary, (b) 6 A of
current is in a 10-4 device connected to the secondary, and (c) the power supplied to the primary is 360 W. Figure 4.18 shows specific vertical distances for a cannonball shot at an upward angle. If an atom were the size of a baseball stadium, one of its electrons would be smaller than a grain of rice. A very small or very large visible object can be
represented with a physical model, which is a model that replicates the object at a more convenient scale. (b) The nutrients in the water have been destroyed. What are the chances that microbial life forms might one day be found elsewhere in our solar system? Why do sugar crystals dissolve faster when crushed? No. The planar surfaces in cleavage
are where a mineral breaks due to a weakness in the crystal structure or bond strength. Chemical impurities affect color, and many minerals come in multiple colors. Some has to come back down. With more thermal motion it then vaporizes. Fusion brought about by high temperatures is called thermonuclear fusion. A friend says that the reason one's
hair stands out while touching a charged Van de Graaff generator is simply that the hair strands become charged and are light enough so that the repulsion between strands is visible. The cubic arrangement of sodium and chloride ions. Newton's second law, the law of acceleration. When a net force acts on an
object, the object accelerates. Or it may be calibrated to measure electric potential (volts), in which case it is called a voltmeter.* Electric Motors Rotating loop Stationary contacts Current FIGURE 9.21 INTERACTIVE FIGURE A simplified motor. The Kuiper Belt and Dwarf Planets Beyond Neptune at a distance from about 30 to 50 AU is a region
known as the Kuiper belt (pronounced "KI-pur," "KI" as in kite, rhymes with hyper). The ionic bond involves a transfer of one or more electrons, and the nonpolar covalent bond involves the equitable sharing of electrons. They look to you for confirmation. General theory first proposed by Einstein discussing the effects of gravity
on spacetime. Scientists took more than two years to extract enough U-235 from uranium ore to make the bomb that was detonated at Hiroshima in 1945. Quartz is another mineral that is not platy or elongated. When can you withdraw heat from a substance without lowering its temperature? 2 Galileo's Concept of Iner tia 1. Ordinary matter Matter
that responds to the strong nuclear, weak nuclear, weak nuclear, electromagnetic, and gravitational forces. Dried, odor-free compost, which is removed every few months, is useful as a garden fertilizer. Don't confuse the physics definition of work with the everyday notion of work. Light of middle frequencies stimulates the cones that are sensitive to middle
frequencies and appears green. But if the time is short, the force is large. 60. The reason a 10-kg rock has greater acceleration. If this tangential velocity were reduced to zero, what would be the fate of the Moon? 5 The Theor y of Plate Tectonics 21. Change is the key, so the
electromagnet should be powered with ac. The resulting stain is shortening of the rock bodies. We see application of this rule when we look at a spinning top. The reason for this is the presence of more water molecules along the freshwater face of the membrane than along the saltwater face. FIGURE 10.21 The superposition of two identical
longitudinal waves in phase produces a wave of increased intensity. Regional metamorphism combines recrystallization with mechanical deformation. Choose the BEST answer to each of the following. Archimedes' problem was to determine the density of the crown without destroying it. FYI S cience made great headway in Greece in the 4th and 3rd
centuries BC and spread throughout the Mediterranean world. 88 PA R T O N E P H Y S I CS 114. An increase in pressure in one part of a confined fluid is transmitted throughout the fluid to all parts. CHECKPOINT What is the significance of heteroatoms in an organic molecule? A dramatic demonstration of the cooling effect of evaporation and
boiling is shown in Figure 7.31. * Close inspection shows that brief friction between the dishes and table stops the dishes moving, but then friction between the dishes and falls according to variations in density (Figure
21.9). Halfway up the stack, the pressure is half because the weight of the bricks above is half. Tutorials for chemistry, astronomy, physics, and earth science are all available in the item library for Conceptual Physical Science. Consider the cylinder with the movable piston in Figure 5.19. Why doesn't this uranium ore undergo an explosive chain
reaction? 201 r. Arrows indicate the direction of compressive force. (d) all of these 5. Suppose the division time for a certain strain of bacteria is 1 minute. In air, light travels a million times faster than sound. The larger the head space, the greater the amount of carbon dioxide that comes out. (a) Speed = = = 10 km/h. The equivalent resistance of
resistors in parallel is less than the lower resistance of the two. The minimum length of a vertical mirror must be half your height in order for you to see a full-length view of yourself. What are meteors, asteroids, and comets? Nukes, on the other hand, are required to have shielding to ensure strictly low levels of radioactive emissions. Or when we
divide by s 1, s 2, we can express this as ms * m = m (which can also be written as (m/s)/s, or ms-2). Notice also that the mass of the ball, not showing in the (a) As with Sample Problem 1, the physics concept here involves project tile motion in the absence of air resistance, where horizontal and vertical components of velocity are independent. Calcium
is readily absorbed by the body for the building of bones. Each second, approximately 657 million tons of hydrogen is fused to 653 million tons of helium. 8.9 Electric Circuits 26. (b) The presence of chlorine atoms lowers the activation energy, which means more reactant molecules have sufficient energy to form product. And fossils of nearly identical
trees are found in South America, India, Australia, and Antarctica.* Even stronger evidence for a suAfrica percontinent was found by studying South America paleoclimatic (ancient climate) data. (c) both of these (d) neither of these 2. EXPLAIN THIS E lements with unstable nuclei are said to be radioactive. As the plates move, Earth's surface
changes. Similarly, concrete roadways and sidewalks are intersected by gaps, which are sometimes filled with tar, so that the concrete can expand freely in summer and contract in winter. If you had 1 mole of marbles, how many marbles would you have? The water surface at one end of the hose will be at the same elevation above sea level as the
water surface at the other end of the hose. (b) molecules are heavier. Ken and Joanne are astronauts floating some distance apart in space. Shear stress occurs when slabs of rock are both pulled and pushed. Yes. It is stated as follows: 3 1 An immersed body is buoyed up by a force equal to the weight of the fluid it displaces. If a 1-m-long bar expands
0.6 cm when heated, a bar of the same material that is 100 times as much, 0.6 cm for each meter, or 60 cm. Of the photosphere, chromosphere, and corona, which is thinnest? The potential for pathogens to grow in primary effluent is extremely high and, by virtue of the Clean Water Act of 1972, the release of primary
effluent is not permitted in most places. Each dot represents a galaxy. 8.5 Voltage Sources 15. Instead, these electrons can move freely around the ring. It has been named "Lucy" after the Beatles song "Lucy in the Sky with Diamonds." In about 7 billion years, our own star, the Sun, is also likely to crystallize into a huge diamond ball. Suppose the
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cannonball in Figure 4.18 were fired faster. This work increases the energy and hence the mass of the nucleon outside the nucleus. The first box illustrates ice melting, which occurs at 0°C. Hence, gamma rays are generally more harmful to us than alpha or beta particles (unless the alphas or betas are ingested). Hewitt 723: (top) NASA Earth
Observing System 723: (middle) Lick Observatory 724: NASA 726: (top) Detlev van Ravenswaay/ Photo Researchers, Inc. (c) CHECKPOINT 1. 2 Wave Motion 10. Why is it needed in this activity? When two symbols are written together, such as the at in this case, it is understood that they are multiplied.) How fast the ball rolls is one thing; how far it
rolls is another. To see the Moon, you will need to be on the Moon side of the planet, where perhaps real estate prices will be higher because of the view. A solar or lunar eclipse occurs only when the Moon intersects the Earth-Sun plane (points A and B) at the precise time of a three-body alignment. Convection currents stir the atmosphere and
produce winds. Also, although Styrofoam is insoluble in water, it is soluble in acetone, a solvent used in fingernail polish remover. So physics is basic to both physical science and life science and life science and life science. How does the reading on the scale compare with her weight? CHAPTER 2 N E W TO N 'S L AW S O F M OT I O N FIGURING PHYSICAL SCIENCE Problem
Solving If we know the mass of an object in kilograms (kg) and its acceleration in meters per second (m/s2), then the force will be expressed in newtons (N). Air is a mixture of molecules that move randomly and collide with one another like billiard balls on a pool table. Downward at constant velocity? The crust is subdivided into
continental crust and oceanic crust. This is easily done using a radiation detector (Figure 13.16). Compressional stress pushes rocks together. T REVIEW 89 131. All are treated conceptually, with the twin goals of enjoyment and understanding.
speedboat knifing through the water. (c) If the airplane somehow continues to fly as if nothing had happened, where is the engine relative to the airplane at the moment the engine hits the ground? Film badges monitor gamma radiation, which is very high frequency X-rays. So in a zone of normal faulting we would find extension of the crust. For very
long-range projectiles, however, the curvature of Earth's surface must be taken 40 m/s into account. The more protons there are in a nucleus, the more neutrons are needed to help balance the repulsive electric forces. With this high probability of comets in the sky, why aren't more of them found? Mercury's density is 13.6 g/cm3, which means the repulsive electric forces.
that it has 13.6 times as much mass as an equal volume of water. This explains how people who fall into frozen waters can sometimes be resuscitated even though they haven't been breathing for more than an hour—their cells were shut down uniformly because of the rapid onslaught of the extreme cold. a, c, d, b. The many electrons dislodged from a
large group to how the atoms of that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically bonded. In the early 1900s, Albert Einstein discovered that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically bonded. In the early 1900s, Albert Einstein discovered that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically bonded. In the early 1900s, Albert Einstein discovered that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically bonded. In the early 1900s, Albert Einstein discovered that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically bonded. In the early 1900s, Albert Einstein discovered that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically bonded. In the early 1900s, Albert Einstein discovered that metal of metal atoms flow freely through the resulting metal ions, as is depicted in are chemically flow freely through the resulting metal atoms from t
their accelerations compare, and how far does each person slide before they meet? This occurs when the Moon is between Earth and the Sun (position 1 in Figure 26.25). How can your community overcome these obstacles? If the storm intensifies, it progresses to a tropical storm, with increased wind speeds above 60 km/h. (b) What force of air
resistance will she encounter when she reaches a lower terminal velocity after the chute is open? Suppose two carts, one twice as massive as the other, fly apart when the compressed spring that joins them is released. The location of each cross-section is shown on its respective map. So the amplitude equals the maximum displacement from
equilibrium. What important discovery did physicists Michael Faraday and Joseph Henry make? (b) PEBart = PEArt MghBart = mghArt M hArt = h. In the box on the right, show what they would look like if heat were added. The probability of another nearby star exploding soon is quite low. This means the overall resistance of the circuit is less than
the resistance of any one of the branches. Momentum is indeed conserved. The density of air inside is also greater than that of the air outside. This process, which is still in use by manufacturers today, greatly facilitated mass production of Oxidation 2 AlOF32 \leq 6 F \geq 6 F \geq 6 C 2 AlF63 \geq 6 E \geq 6 C 2 AlF63 \geq 6 E \geq 7 E \geq 7 E \geq 7 E \geq 8 E \geq 8 E \geq 9 
The melting point of aluminum oxide (2030°C) is too high for efficiently electrolyzing to aluminum metal. (c) are composed of plasma. Porosity is the volume of solids plus voids. Moving at an average speed of 500 m/s (b) Liquid (1100 mi/h), the particles of a gas are widely separated
from one another. Relative humidity is the ratio of the amount of water vapor currently in the air to the maximum amount that could be in the air at a given temperature. But, approaching the edge of the platform, tangential speed increases. This provides residual protection against diseases. There has been a lot of new and exciting physics since the
time of Isaac Newton. In Figure 10.20, we see the interference pattern produced when two vibrating objects touch the surface of water. Mathematics and Conceptual Physical Science 3. Does light, then, similarly slow down when it passes through glass and also emerge at a lower speed? The relative areas are as the squares of the diameters: 62/22 =
36/4 = 9. (c) conversational, orthodontic, and face lifting. The density of the ocean water is 1025 kg/m3. This is even more dramatic when you wedge chunks of ice with steel wool at the bottom; then the water above can be brought to a boil without melting the ice. While he exerts a force through a distance, he does work on the barbell and changes its
potential energy. Ask your friends to estimate the hang time of the great jumpers—the time a jumper is airborne with his or her feet off the ground. Consumers are buying magnetic bracelets, insoles, wrist and knee bands, back and neck braces, pillows, mattresses, lipstick, and even water. Is the following explanation valid? The eclipse time in any
 location is brief because of the Moon's motion. Open ended. Objects nicknamed Sedna and Buffy, discovered in 2005, are nearly the size of Pluto. (Note: The unit N/kg is equivalent to m/s2.) Fnet m 36. is halved. (b) Lines of force for a pair of equal but opposite charges. Or look at a billboard up close. The greater the distance traveled each second, the
faster the horse gallops. What is the speed of X-rays in a vacuum? Galaxies are the breeding grounds of stars. The dashed straight lines at the top show the ideal trajectories of the stones if there were no gravity. The offset ridge segment to another. The
second reason was reservations about it himself; he could not reconcile the idea of a moving Earth with the prevailing ideas of motion. What is the percent volume of water in 80-proof vodka? 4 4 Dispersion by a prism makes the components of white light visible. Hubble's law The farther away a galaxy is from Earth, the more rapidly it is moving away
from us: v = H * d. Recall Newton's third law about action and reaction forces. Sulfuric acid loses two protons to form the sulfate ion, SO24 .A water molecule loses a single proton to form the rug in the same way you charge a rubber rod
by rubbing it with cloth. Table C.1 summarizes the amount of space left in the bottle in the last few minutes before noon. Relate the terms to practical examples. That is, when the mixture forms, atoms are not exchanged between the components. Earth's interior is mostly solid, not molten. We see the system bounded by the dashed line in Figure 2.26.
The most well-known dwarf planet is Pluto, which was downgraded from planet status in 2006. Chemical impurities in a mineral affect color. This means that 436 kJ of energy is released upon the formation of 1 mole of hydrogen-hydrogen bonds. Alex says
acceleration is how fast you get fast. What will be the kinetic energy of the ram of a pile driver when it suddenly undergoes a 10-kJ decrease in potential energy? Why are people who are confined to bed less likely to develop bedsores on their bodies if they use a waterbed rather than a standard mattress? Bertrand Russell wrote, "I think we must
retain the belief that scientific knowledge is one of the glories of man. C H A P T E R 15 H O W ATO M S B O N D A N D M O L E CU L E S AT T R AC T 373 FIGURE 15.7 Ions formed Electron transfer Ionic bond + - Na Na Cl Cl Na+ Sodium and chloride ions Sodium and chloride ions Sodium and chloride ions Sodium chloride, NaCl 2 1 Cl 3 CHECKPOINT Is the transfer of
an electron from a sodium atom to a chlorine atom a physical change or a chemical change? An example of a solid solution is the alloy white gold, which is a homogeneous mixture of the elements gold and palladium. Then hold the mouth of the water-filled glass downward above the air-filled glass. (d) light. Magma produced by the partial melting of
KANDRANK (ANALYSIS) Energy Energy 42. The object would weigh less on the Moon. 4 Acidic Rain and Basic Oceans 18. CHAPTERIOR563 icebreakers cutting through ice.) Without a convincing explanation for his hypothesis, it was dismissed. When the buildup of
stress exceeds the rock's elastic limit, the rock breaks and slips into a new position—a fault forms. High-density polyethylene (HDPE), shown schematically in Figure 19.27a, consists of long strands of straight-chain molecules packed closely together. Might adding too much iron initiate another ice age or alter the ocean's ecology? As force is
increased, distance is decreased by the same factor. These intriguing questions and more will be answered in this chapter. This is thermonuclear fusion, a process that releases radiant energy, a small part of which reaches Earth. An initial flow of electrons through the wire imme- electrons, them from migrating. Direct current (dc) refers to charges
flowing in one direction. It then deposits this material on its own surface as a very dense hydrogen layer. Using the formula power = current * voltage, show that the current drawn by a 1200-W hair dryer connected to 120 V is 10 A. Only two diatomic molecules are represented (not three!). So when water from a firefighter's hose hits you, the impulse the formula power = current * voltage, show that the current drawn by a 1200-W hair dryer connected to 120 V is 10 A. Only two diatomic molecules are represented (not three!).
can knock you off your feet. Copper has the chemical property of reacting with carbon dioxide and water to form a greenish-blue solid known as patina. Evaporites are minerals and rocks precipitated when a restricted body of seawater, or the water of a salty lake, evaporates. In Newtonian space and time, space has three dimensions—length, width,
and height—each with two directions. In fact, many fire walkers prefer dry feet because sometimes hot coals stick to wet feet (ouch!). Experiments reveal that the concentration of hydronium and hydroxide ions in pure water is extremely low—about 0.0000001 M for each, where M stands for molarity or moles per liter (Section 16.3). The solution to
this problem is to allow ions to migrate into either container so that neither builds up any positive or negative charge. The rate at which carbon dioxide molecules leave an opened soft drink is relatively slow. How can you account for this? What are the three main atmospheric lifting mechanisms? Hewitt 454: Shutterstock 455: (top a) Corbis/Alamy
455: (top b, c, d) Pearson Education/Pearson Science 455: (bottom a, b, c) Pearson Education/Pearson Science 455: (bottom d) Eric Schrader/ Pearson Education/Pearson 
Schrader/Pearson Science 467: (left) M. Solar flares, coronal mass ejections, and magnetic storms affect not only Earth satellites but Earth's surface environment as well. Because of its tangential velocity, it "falls around" the round Earth (as we shall investigate later in this chapter). The rusting of a car, by contrast, is the result of the transformation
of iron to rust. Where is your weight greater: on Earth or on the Moon? Show that the quantity of heat needed to raise the temperature of a 10-kg piece of steel from 0°C to 100°C is 450,000 J. 11.7 Polarization 27. In which glass are the water molecules moving faster? Now you know why speakers are mounted in enclosures. How could you check to
see if this is true (without any scraping)? The dipoles of the water molecules all turn toward the charged balloon to which they are attracted. The intensity of fusion reactions is measured by the accompanying neutron flux. Atomic mass is a measure of the total mass of an atom, which is given in atomic mass units. Which of these did Aristotle favor,
and which did Galileo favor? Two observers standing apart from each other do not see the "same" rainbow. At convergent boundaries, magma generation occurs deeper in the mantle, and the rising magma is impeded when it encounters the overlying lithosphere. 7 The Advent of Nanotechnology A s you progress through this physical science course
you will note an accumulating list of key terms. In Figure 3.10, most of the cannonball's momentum is in speed; most of the recoiling cannon's momentum is in mass. The craft will move to the right because two impulses act on the recoiling from the wind it produces. How is this favored by entropy? For
example, the stars Betelgeuse and Procyon appear equally bright even though Betelgeuse emits about 5000 times as much light as Procyon. But when heated, it becomes a hard ceramic. The 1986 nuclear power plant accident at Chernobyl, in which dozens of people died and thousands more were exposed to cancer-causing radiation, created fear and
outrage worldwide and led some people to call for the closing of all nuclear plants. Some require that the student recall earlier material. Thus, a clock sitting on the less massive planet. Generation of Magma We've learned that many minerals form from
cooling magma. Which of the following are scientific hypotheses? During a physical change, a substance change only one or more of its physical properties; its chemical identity does not change that the speed of sound in seawater is 1530 m/s,
show that the wavelength of a T wave is 219 m. (b) In practice, the rate of consumption levels off and then falls less abruptly to zero. In the daytime, the ground warms up more than the water. If a single disturbance some unknown distance away sends out both transverse and longitudinal waves that travel with distinctly different speeds in the
medium, such as in the ground during an earthquake, discuss how the distance to the disturbance is determined. These equal and opposite forces squeeze an inner springlike device that is calibrated to show weight. If you live where there is snow, do as Benjamin Franklin did more than 200 years ago: Lay samples of light and dark cloth on the snow
and note the differences in the rate of melting beneath the samples of cloth. What is the percentage carbon in ethane, C2H6? Rayleigh waves have a side-to-side, whiplike motion. CHAPTER 20 20.5 The Formation of Minerals 13. Use conservation of momentum to show that the speed of Judy and
her dog after the catch is 0.8 m/s. He estimates the distance between wave crests to be 15 m. The Activities provide hands-on applications and can be done in or out of class. The colors on the cover of your physical science book are due to (a) color addition. If you have a cup of hot water and then pour half of the water onto the floor, the water
remaining in the cup hasn't changed its temperature. Distinguish between a solute and a solvent. Barometer Any device that measures atmospheric pressure. These three magma types will be tied to the plate tectonic model in Chapter 21. Gold has the atomic symbol Au after its Latin name, aurum. (a) 28 g of nitrogen, N2 (b) 32 g of oxygen, O2 (c) 16
g of methane, CH4 (d) 38 g of fluorine, F2 4. Molecules with more kinetic energy that make contact with slower molecules give some of their excess kinetic energy to the slower ones. Does this interaction time tend to speed up or slow down the average speed of light in glass? The nuclear charge of a fourth-period potassium atom, however, is much
greater than the nuclear charge of a second-period fluorine atom, but its electronegativity is much less. It picks up speed beF cause the component f reappears f and is in the direction of motion D as shown in position C. During Feynman's time, scientists did not have the technology to manipulate single atoms and molecules. Your mutual friend Steve
says no way. As described in this chapter, the carbon dioxide in the atmosphere reacts with rainwater to produce carbonic acid, which makes rainwater acidic. It's the same as if you catch a high-speed baseball while your hand moves toward the ball instead of away upon contact. As you will learn in the next section, white dwarfs are dead stars, the
remnants of stars that have exhausted their nuclear fuel. Helium, for example, has enough motion at absolute zero to prevent it from freezing. (b) minerals cooled and grew quickly. CHAPTER 9 M AG N E T I S M A N D E L E C T R O M AG 
bunched up when the wire is bent into a loop. Alternatively, we can draw a cloud in which the positions of the two bonding electrons over time are shown as a series of dots. Why will a block of iron float in mercury but sink in water? Little cousins Michelle Anna Wong and Miriam Dijamco produce touching music on page 238. Washington lumbia Co
iver R ba Oregon 0 salts Idaho lava outpourings known as flood basalts have flooded large areas of Earth throughout its history, creating extensive lava plains. How does this resemble, and differ from, the way that natural rain forms? LEARNING OBJECTIVE Distinguish between a star's apparent brightness and luminosity, and identify its temperature
by its color. Recall the legend of Galileo's demonstration at the Leaning Tower of Pisa. Show that the kinetic energy at takeoff is 1000 J. This exercise is similar to the preceding one. So, strictly speaking, the momentum of the willet (if any) + the momentum of the exhaust gases is equal to the opposite momentum of the recoiling gun. F I G U R E 1.1
2 The sum of the upward vectors equals the sum of the downward vectors. Earth is pulled up by the boulder with just as much force as the boulder is pulled downward by Earth. Does distance affect your answer? Starting from rest, Megan zooms down a frictionless slide from an initial height of 4.0 m. Solvent The component in a solution that is
present in the largest amount. From our point of view outside of the black hole, the singularity does not exist at present, only in the infinite future and therefore outside the realm of our observable universe. This book is conceptual, focusing on concepts in down-to-earth English rather than in mathematical language. Its change in apparent brightness
is not discernable to the naked eye. Yes; stream speed can increase without an increase in water volume. 66. These forces compress a spring that is calibrated to show your weight (Figure 1.14). By momentum, we mean inertia in motion or, more specifically, the mass of an object multiplied by its velocity: Momentum = mass * velocity Or, in shorthand
notation, Momentum = mv When direction is not an important factor, we can say Momentum = mass * speed F I G U R E 3 .1 The boulder, unfortunately, has more momentum than the runner. What caused this to happen? For example, the bond in NaCl has an electronegativity difference of 2.23, far greater than the difference of 1.43 shown for the C
i F bond in Figure 15.23. It applies to liquids and gases, which are both fluids. A 30 g NO b = 60 g NO 1 mole NO balanced chemical equation helps determine the amount of products that can be formed from given amounts of reactants. Why do clothes often cling together after tumbling in a clothes dryer? This is one of Paul Hewitt's favorite
classroom demonstrations! 35. Unless one has a shallow understanding of either or both, there is no contradiction in being religious in one's belief system and being scientific in one's understanding of the natural world.* Many people are troubled about not knowing the answers to religious and philosophical questions. Bring a jug of hot water with its
higher specific heat capacity to bed, and you'll stay warm throughout the night. For cancellation, the forces have to be equal and opposite and act on the same object. The reversibility of this process suggests it is a physical change. Why is supercritical water so corrosive? If the black checkers represent silica molecules, can you now see that the
crystallization process enriches magma in silica? How much larger? The required speeds correspond to the extremely He high temperatures found in the core of the Sun and other stars. This occurs when at least one of the bonds between a carbon and a neighboring atom is a multiple bond. How does a wastewater treatment facility treat wastewater found in the core of the bonds between a carbon and a neighboring atom is a multiple bond. How does a wastewater found in the core of the bonds between a carbon and a neighboring atom is a multiple bond. How does a wastewater found in the core of the bonds between a carbon and a neighboring atom is a multiple bond. How does a wastewater found in the core of the bonds between a carbon and a neighboring atom is a multiple bond. How does a wastewater found in the core of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a carbon and a neighboring atom is a finite formation of the bonds between a neighborin
We conclude with an exploration of severe weather, which adds depth to the atmosphere. This is like an S-wave that moves from side to side as it travels. fabricated with silicon. Each sphere in the diagrams below represents an atom. Singularity is still kilometers beneath you, but you are caught within its unrelenting grip. In forming an
ion, the Vacant sodium atom loses this electron, thereby valence making the second shell, which is already shell 1+ filled to capacity, the outermost occupied Na (positive ion) shell. This is in contrast to the non-ionized form of the alkaloid, known as a free base, which is typically insoluble in water. Added to the water pressure is the pressure of the
atmosphere, which is equivalent to an extra 10.3-m depth of water. (d) Both the tin ion, Sn2 +, and the silver, Ag, are oxidized. When the funnel cloud reaches the ground surface, it is called a tornado. The clock consists of a large LED display of blue lights. (b) The same is true even if the bowling alley is larger and remains "level" with the curvature
of Earth. Rank them from fastest to slowest in how quickly each warms up: (a) steel, 450 J/kg # °C; (b) aluminum, 910 J/kg # °C; (c) copper, 390 J/kg # °C; (b) aluminum, 910 J/kg # °C; (c) copper, 390 J/kg # °C; (d) copper, 390 J/kg # °C; (e) copper, 390 J/kg # °C; (e) copper, 390 J/kg # °C; (f) aluminum, 910 J/kg # °C; (g) copper, 390 J/kg # 
estimate the mass of air in your room, estimate the number of cubic meters in the room, multiply by 1.2 kg/m3, and you'll have the mass. Rather, they were receding from us in every direction, which meant that the universe itself was expanding. LEARNING OBJECTIVE Identify the four stages of wastewater treatment 1 billion water bottles wind up in
the trash each year. The United States gave up on breeders about two decades ago, and only Russia, France, Japan, and India are still investing in them. (d) 300 times as much. What steps need to happen before precipitation occurs? Continued improvements in battery technology are permitting next-generation hybrids, known as plug-in hybrids,
which have much larger batteries and smaller fuel tanks. When the siren is approaching you, the crests of the sound waves encounter your ear more frequently, and the pitch is higher than normal. Does it follow that no change in momentum occurs? Why is glass transparent to visible light but opaque to ultraviolet and infrared? Chain reaction A self-
sustaining reaction in which the products of one reaction event initiate further reaction events. This 1 2 3 4 5 6 7 8 GROUPS 9 10 11 12 13 14 15 16 17 18 2 1 1 3 F I G U R E 1 2 .11 The 7 periods (horizontal rows) and 18 groups (vertical columns) of the periodic table. Because liquid water and water vapor are everywhere (excepting liquid water in
polar regions), chemical weathering produces more sediment than mechanical weathering and selection/Pearson Education/Pearson Education/Pe
Georgette Douwma/ Photolibrary.com 397: (top) Getty Images Inc. Although subatomic particles are much smaller than the volume of the atom, the range of their electric field is several times larger than that volume. Two common nonfoliated rocks are marble and quartzite. Throughout the world, most residential and commercial circuits are ac
because electric energy in the form of ac can easily be stepped up to high voltage to be transmitted great distances with small heat losses, then stepped down to convenient voltages where the energy is consumed. Rank the surfaces according to the amount each set of wheels bends at the boundary, from greatest amount of bending to least. Which
gives a higher counting rate on a radioactive material with a short half-life or a radioactive material with a short half-life? Instead of moving ahead of the bug, the waves superimpose on one another directly, forming a hump in front of the bug, the waves superimpose on one another directly, forming a hump in front of the bug, the waves superimpose on one another directly, forming a hump in front of the bug (Figure 10.31).
long-since-eroded volcanoes. If a water wave oscillates up and down three times each second and the distance between wave crests is 2 m, (a) what is its frequency? The blocks consist of the same material, so the 2-kg block also has twice the volume. Beats A series of alternate reinforcements and cancellations produced by the interference of two
waves of slightly different frequency, heard as a throbbing effect in sound waves. (b) The two forces act in opposite directions. With this loss of energy, the ordinary matter loses orbital speed and thus falls closer to the center of the clump. A common horseshoe magnet is a bar magnet bent into a U shape. The polarization axes of the lenses are
vertical because most of the glare reflects from horizontal surfaces. C O 12.011 15.999 The mass of one carbon atom is approximately 12 amu. Partial tones that are whole multiples of the fundamental frequency are called harmonics. Because these strong currents round out the rock fragments, the roundness of their edges and corners is a good
sphere. And in most parts of the mantle, the rocks can actually flow, even though they are solid. Is the temperature of an object or a measure of the average translational kinetic energy per molecules in the object. The Sun, stars, and much of the space between them are in
the plasma phase. Boyle's Law The air pressure inside the inflated tires of an automobile is considerably greater than the atmospheric pressure outside. A new end-of-chapter feature further boosts student comfort with equations, Plug and Chug, which is described below. So think of the melting point as being equivalent to the freezing—that is,
crystallization—point. When you replace helium in a balloon with hydrogen, which is less dense, does the buoyant force on the balloon change if the balloon remains the same size? But air can change temperature without the loss or gain of heat. The dominant reason, in terms of the amount of magma 40 produced, is that hot rock rises upward from
depth to levels where pressure is reduced enough to induce melting.* Another mechanism for generating magma is the addition of 50 water to rock, which lowers the rock's melting point. Although most are small and go undetected, the danger of large earthquakes certainly exists. The modern view of electromagnetic induction states that electric and
than they are at trapping radiated heat. So in the end, as the Sun gets hotter, the amount of water vapor in the atmosphere will drop to near nothing. (b) Their atoms are bonded together in different ways. T = 1600 K Frequency electromagnetic spectrum. By becoming nanotechnology experts ourselves, we would be well equipped to understand exact
causes of nearly any disease or disorder (aging included) and empowered to develop innovative cures. (c) it lacks sufficient dissolved oxygen. The Test Bank allows you to edit questions, and create multiple test versions. CHECKPOINT Is a neutralization reaction best described as a physical change or a chemical change? A rock band's
tour bus, mass M, is accelerating away from a stop sign at rate a when a piece of heavy metal, mass M6, falls onto the top of the bus and remains there. Free fall is motion in which gravity is the only force acting. Notably, these active measures failed when Japan's Generation II Fukushima Daiichi nuclear plant was hit by a powerful earthquake and
tsunami in 2011. FIGURE 8.5 Why do you get a slight shock from the doorknob after scuffing across the carpet? All these features and processes are external expressions of Earth's internal processes. From the definition weight density * volume, where the volume of the
column is simply the area multiplied by the depth. FYI VIDEO: Rainwater is Acidic and Ocean Water is Basic VIDEO: Rainwater is Acidic and Composition CHECKPOINT When sulfuric acid, H2SO4, is added to water, what makes the resulting aqueous solution corrosive? (b) She'll reach the same air resistance, 500 N, but at a lower speed. R E A D I N G C H E C
K Q U E S T I O N S (COMPREHENSION) 2.1 Newton's First Law of Motion 1. Divide your weight in pounds by 2.2, and you'll have your mass in kilograms. Suppose there are twice as many molecules in the same volume (Figure 5.18). Two balls, A and B, are released simultaneously from rest at the left end of equal-length tracks, as shown. In
chemical weathering, reactions with water decompose rock, analogous to the energy in infrared light incident on glass? How true it is: all the parts are intricately connected, down to the level of atoms and molecules! LEARNING
OBJECTIVE Identify when a chemical undergoes oxidation or reduction. There is less resistance in the higher-wattage lamp. Which has greater kinetic energy? Even planet Earth is a slightly "flattened" sphere because of its daily spin. The incoming crests lap against the pier pilings at a rate of one every 2 s. and omitted. In the 18th century, when G
was first measured, people all over the world were excited about it. The most relevant example is water, H2O. In a similar fashion, two atoms can be held together by their mutual attraction for electrons they share. LEARNING OBJECTIVE Recognize the features of the Sun, including its interior, photosphere, sunspots, solar cycle, chromosphere, and
corona. This works because sodium and chloride ions and water molecules are the same scale. CHECKPOINT Which type of weathering produces the most sediment: mechanical or chemical? As will be shown in Appendix A, the relationship between time up or down and vertical height is given by d = 12 gt 2 If the vertical height d is known, we can
rearrange this expression to read t = 2d A g Quite interestingly, no basketball player on record has exceeded 1.25 m in a vertical standing jump. Solution: Convert 300,000 mi/h to light-years per year. O D D - N U M B E R E D S O LU T I O N S Upon careful examination, however, we see that this molecule is simply the result of smaller units joining
together. What is the concentration of hydronium ions in this neutral solution? Because of these vast interplanetary distances, astronomers use the astronomical unit to measure them. In schist, it signifies the age of the metamorphic event. Which of these two chemical equations is balanced? A battery produces direct current in a circuit because the
terminals of the battery always have the same sign. 262 PARTONEPHYSICS 93. Atoms do not have color in the same sense that a macroscopic object may have color. Why does the force of gravity change the speed of a satellite in an elliptical orbit? Several billion years in the future our Sun will grow in size to become a red giant, whose surface
will extend to the present orbit of Earth. Absolutely—created out of the food he eats. If the temperature gets high enough, natural gas is generated rather than oil. Distinguish among a calorie, and a joule. In the United States, potable water is currently used for everything from cooking to flushing our toilets. Friction The resistive force that
opposes the motion or attempted motion of an object past another with which it is in contact, or through a fluid. Alan Guth, one of the early developers of cosmic inflation, supports the idea that the universe will not end everywhere at once. H Fe U Atomic number mass per nucleon. FYI Transmission and/or reflection. Destruction of the ozone layer is a
serious concern because of its role in protecting us from the Sun's harmful ultraviolet rays. It was whipped about by Jupiter's great gravitational field, picking up speed in the process—similar to the increase in the speed of a baseball encountering an oncoming bat. In a typical unit, illustrated in Figure 16.26, hard water is passed through a large tank
filled with tiny beads of a water-insoluble resin known as an ion-exchange resin. Polar molecules tend to stick to one another, which gives rise to relatively high boiling points. The weight of the atmosphere above 1 m2 of Earth's surface is about 100,000 N. If each of these 9 neutrons succeeds in splitting a uranium atom, the next step in the reaction
produces 27 neutrons, and so on. Topics for the geosphere chapters begin in a traditional sequence—rocks and the processes of erosion and their influence on landforms. Are most elements metallic? Ethanol, by contrast, has a boiling point of + 78°C, making it a
liquid at room temperature. If you then push harder and the box slides, you are doing work on it. The relevant factor is not air temperature but solar radiation. Without updrafts, there would be no cumulus clouds. Alternatively, the air parcel
expands and cools sufficiently to match the surrounding air. The concept of isostasy can be made clear with an analogy. Normally, if the companion's orbit were a bit closer to the Sun, then it would orbit faster than Earth and move ahead of Earth. One mole of any type of particle is, by definition, 6.02 * 1023 particles. Why do nonpolar molecules have
a difficult time passing through the bilipid layer? Yes, because the interaction between both occurs during the same time interval. The force of impact is twice what it would have been if he had held his head still. Then P = IV = I(IR) = I 2R. The high temperature of the magma produces a zone of alteration that surrounds the intrusion. In the end, the
planet's supply of water was forever lost. Hewitt 280: Paul G. The Mesozoic era is known as the "age of reptiles." 27. Solubility also depends on attractions of solvent particles for one another and attractions of solvent particles for one another and attractions of solvent particles.
many possible variations in the cycle. For energy release, "decrease mass" is the name of the game—any game, chemical or nuclear. Interestingly, Newton's laws of motion. (a) Show that the impulse supplied to bring the ball to rest is 4.5 N # s. The standard
international (SI) unit of pressure, the newton per square meter, is called the pascal (Pa), after the 17th-century theologian and scientist Blaise Pascal. You provide the energy to charge the capacitor. This tells us that another horizontal force acts on the desk—likely the force of friction between the desk and the floor. (a) the geometry of a mineral's
atomic structure (b) the strength of a mineral's chemical bonds (c) the silica content (d) the number of planes of weakness 10. In any transformation by a fork of any frequency. How many atoms are in a sulfur molecule that has the elemental
formula S8? How does weathering produce sediment? For example, if you drive a distance of 80 km in 1 h, your average speed is 80 km/h. Antifreeze is a practical application of this process. As the kernels are heated, they eventually leave the skillet. (a) chemical change involving the formation of this process. As the kernels are heated, they eventually leave the skillet.
ions (c) chemical change involving the formation of covalent bonds (d) physical change involving the formation of covalent bonds 2. You change your velocity by 5 km/h each second. Electrons and protostar. Because science helps us learn
the rules of nature, it also helps us appreciate nature. What law defends your answer? = 80 g). Why is the rusting of iron considered to be a chemical change? What are the temperatures for freezing water and boiling water on the Kelvin temperature scale? Sound due to multiple reflections is called a reverberation. When an arrow represents a vector
quantity, the arrow's length represents magnitude and its direction shows the direction force Vectors that are not shown: the normal force N, which is equal and oppositely directed to D, and the friction force vectors that are not shown: the normal force N, which is equal and oppositely directed to D, and the friction force vectors that are not shown:
 f, acting at the barrelFIGURE B.9 plane contact. LEARNING OBJECTIVE Recognize how radioactive elements can be identified by the rate at which they decay and how this decay results in the formation of new elements. (b) warmed. After passing C, it gains speed as it falls back to A to repeat its cycle. Show that 27,000 cal is required to change 50 g
of 100°C boiling water into steam. 1 Radioactivity 13. 4 5 Dispersion of sunlight by a single raindrop. The objects aren't charged because of their equal number of 26 is written: ATO M S A N D T H E P E R I O D I C TA B L E FIGURE 12.7 Isotopes of an element
have the same number of protons but different numbers of neutrons and hence different mass numbers. Use these masses to help answer the next question. This is similar to the preceding two questions. Magnet A has twice the magnet B with a force of 50 N. The number of
calories released by the burning nut can be calculated by the formula Q = cm©T, where c is its specific heat capacity (1 cal/g # °C), m is the mass of water, and ©T is the change in temperature. In atoms, electrons move at speeds of about 2 million m/s, and so their wave nature is most pronounced. If you remain inside and push on the dashboard, the
force pair you produce acts and reacts within the system. In an accidental explosion, a satellite breaks in half while in circular orbit about Earth. During this time, the atom undergoes about 1 million vibrations, collides with neighboring atoms, and transfers absorbed energy as thermal energy. Pure The state of a material that consists solely of a single
element or compound. E lectromagnetic induction explains the induction of voltages and currents. The carrier frequency of electromagnetic waves emitted by the radio station is 101.1 MHz. 103. 19.4 Alcohols, Phenols, and Ethers 11. Do you notice a difference in the temperature of exhaled air? Hewitt (middle) Paul G. (Be glad this is so, particularly if
you sit far from the stage or if you like outdoor concerts.) 107. Motion of the lid is indicated on a scale by a mechanical spring-and-lever system. This may result in whiplash. It occurs when one object rubs against something else.* Friction occurs for solids, liquids, and gases. Only part of the light that strikes a surface is reflected. If 6 V were
impressed across the circuit in Question 26, and the voltage across the first lamp were 2 V, what would be the voltage across the second lamp? Basalt is a common volcanic rock. From I = V/R, if both voltage and resistance are doubled, current remains unchanged. Electrons are rubbed off the rod and onto the silk. Chemical reaction A term
synonymous with chemical change. Throw ten coins onto a flat surface. We begin with a tour of the universe with a focus on our solar system, which on a cosmic scale is Earth's own backyard. The answer is found in their density differences and buoyancy (Chapter 5). Bohr was serious when he stated that electrons could never exist between permitted
energy levels! ATO M S A N D T H E P E R I O D I C TA B L E 311 n=4 Electron n=3 n=2 n=1 Nucleus FIGURE 12.26 Bohr's planetary model of the atom, in which electrons orbit the nucleus much as planets orbit the Sun, is a graphical representation that helps us understand how electrons can possess only certain quantities of energy.
Formaldehyde is harmful to the eyes, can lead to blindness, and was once used to preserve dead biological specimens. (b) any location north of the equator. If a star collapses to a tenth of its original size, the distance between the surface and the center of the star is onetenth as much. CHAPTER 4 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L
T E S Recent evidence suggests that the universe is expanding and accelerating outward, pushed by an antigravity dark energy that makes up some 73% of the universe. Water used to be classified as an element, but that was before people recognized that the basic building blocks of matter are the tiny particles S-15 called atoms. If the snow is dirty,
it absorbs radiant energy from the Sun and melts faster. Because the hydrogen side of the water molecule are pulled toward the water molecule (rather than as far away as possible, as it
was in Figure 15.35). Alex is correct because Gracie is describing speed. Tribarium dinitride or, more simply, barium nitride because no ratio other than three bariums to two nitrogens is possible. Our Local Group of galaxies is also under the gravitational influence of neighboring galactic clusters. Sound consists of longitudinal waves. A B 130. You
run your engine to provide a force large enough to overcome friction. Their planetary status was removed when Copernicus substituted the Sun for Earth's central position. The top-down approach is an extension of LEARNING OBJECTIVE Show how nanotechnology is a novel and promising application of chemistry. Entropy, as discussed in Section
6.6, is a measure of this natural spreading of energy. What is the chemical formula for the ionic compound barium nitride? At sea level, atmospheric pressure is about 101 kPa. Barometer Any device that measures atmospheric pressure is about 101 kPa. Barometer Any device that measures atmospheric pressure is about 101 kPa. Barometer Any device that measures atmospheric pressure.
30.01 amu. When the crest of one wave overlaps the crest of another, their individual effects add together. During a chemical reaction, new materials are formed by a change in the way atoms are bonded together. A net force of zero requires that you provide this force. Psychological comfort is a benefit of having solid
answers to religious questions. (c) the Sun. Quantum fluctuations were amplified by a sudden burst in size during a period known as inflation. If your car is hit from the rear and the back of your head is not supported by a headrest, your head is not supported by a headrest, your head is not pushed forward with the rest of your body. Try it and see! Then explain what happens. This
characteristic follows from the fact that the amount of energy given to the total current is equal to the sum of energies given to each device. The strawberries on the right were treated with gamma radiation, which kills the microorganisms that normally lead to spoilage. Metamorphic rock can be found at all three plate boundaries. Refer to the
preceding question. FIGURE 18.21 A nail made of iron placed in a solution of Cu2 + ions, which dissolve in the water. The salt lowers the freezing point of water, so 0°C is no longer cold enough to keep the ice frozen. A friend says that molecules in a mixture of gases in thermal equilibrium have the same average kinetic energy
Galileo allegedly showed the falseness of Aristotle's claim with one experiment—demonstrating that heavy and light objects dropped from the Leaning Tower of Pisa fell at nearly equal speeds. The vibrations along a transverse wave move in a direction (a) parallel to the wave direction. Momentum has only one form. F I G U R E 2 5 .1 7 The mature
stage of a thunderstorm cloud appears as a towering cumulonimbus cloud that reaches up to about 12 km. What law guides your answer? This ground movement is recorded on a seismograph (Figure 21.2). In practice, this doesn't happen, and we can never expect it to happen. Amine An organic molecule containing a nitrogen atom bonded to one or
more saturated carbon atoms. To understand the relationship between instantaneous velocity and average velocity. E X E R C I S E S (SYNTHESIS) 41. At its center is one of the most supermassive black holes measured in any nearby galaxy. What kind of radiation
do these devices monitor, and how can they determine the amount of radiation people receive? If air resistance can be neglected, how does this compare with the horizontal component of its velocity at other points? CHAPTER 5 F L U I D M E CH A N I CS 125 Perhaps your instructor will summarize Archimedes' principle by way of a numerical
example to show that the difference between the upward-acting forces on a submerged cube (due to differences of pressure) is numerically identical to the weight of fluid displaced. The benefits of fission power include plentiful electricity and the conservation of many billions of tons of fossil fuels. The process of extracting
energy (for instance, breaking down a highly organized food molecule into smaller molecules) increases entropy elsewhere, so life forms plus their waste products have a net increase in entropy. (With g = 9.8 m/s2, these distances are more precisely 4.9 m, 19.6 m, and 44.1 m.) 102 PA R T O N E P H Y S I CS F I G U R E 4.1 9 INTERACTIVE FIGURE
Ranges of a projectile shot at the same speed at different projection angles. If neither air mass is moving, the contact zone is called a stationary front. If a solute has any appreciable solubility in a solvent, then that solute is said to be soluble in that solvent. The Italian physicist Galileo Galilei was arrested for popularizing the Copernican theory and for
his other contributions to scientific thought. Precession in the orbits of planets caused by the gravity of other planets was well known. And because high-silica minerals have low melting points and are the first to melt, the resulting magma contains more silica. The type of surface over which air-mass formation occurs is designated by a low- F I G U R
E 2 5. The peak frequency f of the radiation is directly proportional to the absolute temperature T of the emitter: Interestingly, the Earth's atmosphere is transparent to a narrow band of light centered upon the Sun's peak frequency. Calculations are not necessary. This is similar to the micelle shown in Figure 16.23, though notably different because
it contains an inner compartment of water. Which of these things has a temperature (a) lower than, (b) greater than, and (c) equal to the temperature of the air? So early Earth may have had a twin that paraded with Earth around the Sun much like two horses running side by side on a circular track. (top right) John Suchocki/ Paul G. How tilted is
actually less dense than polyethylene—even lowdensity polyethylene. Hewitt 264: Paul G. When the magnetic strip on the back of a credit card is scanned, induced voltage pulses identify the card. (The common form of hydrogen, which has no neutrons, is the only exception.) All protons are positively charged and identical; similarly, all neutrons are
identical. A B M 2M m m d d 58. C H A P T E R 10 WAV E S A N D S O U N D 247 F I G U R E 1 0 .1 6 (a) (b) (c) (d) (e) If you drop a wrench and a baseball bat on a concrete floor, you easily notice the difference in their sounds. The station facility and astronauts all accelerate equally toward Earth, at somewhat less than 1 g because of their altitude.
rock is intruded by magma (Figure 20.32). Show that the weight of the load is 360 N. Even the cleanest rain contains radioactive carbon-14, as do our bodies. Identify the force that moves the car. When the two atoms in a covalent bond have the same electronegativity, no dipole is formed (as is the case with H2) and the bond is classified as a
nonpolar bond. The remaining atoms have been created in the laboratory. Name the three major types of rocks, and describe the conditions of their origin. Nonfoliated Metamorphic Rocks Nonfoliated metamorphic rocks can form because of increased temperature alone. (b) Red light doesn't bend so
nebula, the protosun, was a clump of gas and dust that became the Sun when thermonuclear fusion ignited within it. In the same way, a boat sailing downwind experiences a decreased wind impact force, while a boat sailing downwind experiences are decreased wind impact force, while a boat sailing downwind experiences are decreased wind impact force.
element not yet discovered on Earth. When the small piston in Figure 5.31 is moved downward 10 cm, the large piston is raised only one-fiftieth of this, or 0.2 cm. What patterns of alteration are characteristic of contact metamorphism? 15.7 Molecular Polarity 20. A hydrogen atom does not form more than one covalent bond because it (a) has only one-fiftieth of this, or 0.2 cm.
shell of electrons. Water waves spread over the flat surface of the water. 120. Any society striving toward a policy of zero risk would consume its present and future economic resources. So it floats, where the buoyant force equals the weight of the can. F Ca F Fluorine atom Fluori
main component of such gemstones as rubies and sapphires. This occurs because alpha particles have more inertia (mass) than beta particles have more inertially upward, then departs from a vertical course and continues its climb at an
angle. What happens to the properties of elements across any period of the periodic table? (b) If the ball leaves the tabletop at a speed of 4.0 m/s, the tabletop is 1.5 m above the floor, and the can is 0.15 m tall, show that the center of the can should be placed a horizontal distance of 2.1 m from the base of the table. The light coming from any object
farther than 14 billion light-years has not had sufficient time to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium, and in Appendix A we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss thermal equilibrium to reach us. Because there is no creation or destruction of the lithosphere. In Chapter 6 we'll discuss the reach us. Because the reach us. Becau
F Exactly what is transmitted in all kinds of waves? For humans, the chance of dying increases with age. When Accelerations, wouldn't he have loved to know the rule a = F/m? Thermal energy is the graveyard of electric energy. According to Table 15.1, the
carbonate ion carries a 2 - charge, which means it has picked up two electrons. Rank these covalent bonds in order of increasing bond strength: (a) C, C, (b) C "C, C) C i C. FIGURE 9.26 Guitar pickups are tiny coils with magnets inside them. F I G U R E 1 8.1 9 The ability of an atom to gain or lose electrons is indicated by its position in the periodical carries and carries are tiny coils with magnets inside them. F I G U R E 1 8.1 9 The ability of an atom to gain or lose electrons is indicated by its position in the periodical carries and carries are tiny coils with magnets inside them.
table. This occurs with heat pumps that move heat from a home's warmer interior, or with air conditioners that remove heat from a home's warmer air outside. Astronomers usually view the night skies during two-week periods every two weeks. Instead, atoms from the two of you get close enough so that you
sense an electrical repulsion. (d) The acid-base reaction would release heat, which would cause the diethyl ether to start evaporating. The way these atoms are put together, however, is different. What is the efficiency of a machine that miraculously converts all the input energy into useful output energy? Convergent plate boundary A plate boundary
where tectonic plates move toward one another; an area of compressive stress where lithosphere is recycled into the mantle or shortened by folding and faulting. What properties of slate make it good roofing material? One force is that due to gravity—the weight of the book. Vibrations in a transverse wave are pe
parallel to wave travel in longitudinal waves. In such cases, most rising air parcels can't pass through the upper layer of warmer air, because the rising air is cooler and denser. A typical chest X-ray exposes a person to 5-30 mrem (0.005-0.030 rem), less than 1>10,000 of the lethal dose. (b) Surrounding the solidified intrusive rock is a zone of
alteration. It was also the preferred direction of rotation for planets—which is why most planets rotate in the same direction today. We say it has kinetic energy (KE). Using this technique, you may come to the point of being able to distinguish your bare presence from your discursive thoughts. The rest spreads into the engine block and radiator fluid
and then out the exhaust pipe. Similarly, the corrosive action of a basic solution results from the hydroxide ions it contains, regardless of the base that generated those hydroxide ions. See also Geologic time scale inclusions and, 621 lateral continuity and, 622 original horizontality and, 621 radiometric dating and, 625-626 relative dating and, 621-
625 superposition and, 621 unconformities in, 623-624 S Safety fuses, 205-206 Salinity, of oceans, 652-653 Salts, 458-459 Sand dunes, 615 Saturated hydrocarbons, 494 Saturation vapor pressure, 683 Saturn, 710, 720-721 Scanning probe microscopes,
360 Schist, 547 Science, 1 art and, 7-8 astronomy, 9-10 chemistry, 9-10 conceptual physical, 2-3 earth, 9-10 history of advances in, 2 limitations of, 6 mathematics, 2-3 overview of, 1-10 physics, 9-10 religion and, 7-8 technology and, 8-9 vs. As we will see, all rainbows would be completely round if the ground were not in the way.
Light will not pass through a pair of Polaroid filters when they are aligned perpendicularly. EXPLAIN THIS R ecall from Section 15.1 that carbon has four unpaired valence electrons. If you look into the night sky, you will see that stars differ in two very visible ways: brightness and color. Suppose a 10-kg load is placed on the left piston. The elemental
iron and copper ions need not be in physical contact for electrons to flow between them. How many electrons has each manganese atom lost to make this compound? 84 PARTONEPHYSICS Impulse g Ft 37. Instead of being a very small number, like G, k is a very large number, approximately Electron Satellite Planet (a) FIGURE 8.6 (a) A
gravitational force holds the satellite in orbit about the planet, and (b) an electrical force holds the electron in orbit about the proton. CHECKPOINT Which structural isomer shown in Figure 19.1 should have the highest octane rating? 3 Magnetic Domains 9. But this could be either 3 Hz above or 3 Hz below. Don't confuse supersonic with ultrasonic
The sketch shows a painter's scaffold in mechanical equilibrium. The second law of thermodynamics, therefore, gives us our psychological sense of time; it is the "arrow of time." F I G U R E 17. When you weigh yourself, how does the support force of the scale acting on you compare with the gravitational force between you and Earth? The result is a
temporary dipole, as shown in Figure 15.38. Electromagnetic induction occurs as built-in magnet slides to and fro between coils that charge a capacitor. The force needed is the weight of 1 L of water, which is 9.8 N. Reflection The return of light rays from a surface in such a way that the angle at which a given ray is returned is equal to the angle at
which it strikes the surface (also called specular reflection). This unit was named in honor of James Watt, the 18th-century developer of the steam engine. 30 m/s. A dramatic example is the use of high-speed jets of water to cut steel in modern machine shops. Since Rutherford's announcement in 1919, experimenters have carried out many other
nuclear reactions, first with natural bombarding projectiles from radioactive ores and then with still more energetic projectiles—protons and electrons hurled by huge particle accelerators. What does this tell you about its specific heat capacity? Ion-dipole attractions are much weaker than ionic bonds. The reading in the left scale is 800 N. The only
difference here is that both types of reactive ends are on the same molecule. Instead the carbon dioxide would build up in the atmosphere and hence melt the frozen Earth. REVIEW 449 22. Flow rate = hydraulic conductivity * cross-sectional area * hydraulic gradient. Exposure times differed, depending principally
on the kind of film and the amount of light. Convection The transfer of thermal energy in a gas or liquid by means of currents in the heated fluid. As shown in the drawing, the half-angle of the shockwave cone generated by a supersonic aircraft is 45°. Even the energy we obtain from petroleum, coal, natural gas, and wood originally came from the
Sun. Because the general direction of all dipole arrows is toward the fluorines, so is the average distribution of the bonding electrons. This is analogous to two attracting magnets, whose potential energy decreases as they come closer together. We now know that objects in free fall, whatever their weights, undergo the same gain in speed. Assertions
without evidence are unscientific and can be dismissed without evidence. 15.5 Covalent Bonds LEARNING OBJECTIVE Describe how atoms combine to form covalent compounds. But when the bottom string is jerked, the mass of the ball—its tendency to remain at rest—is responsible for breakage of the bottom string. (If your three answers are the
same, seek help; this question is especially important.) 25. The hydrogen escaped into space while the oxygen chemically reacted with minerals on the surface. FYI F I G U R E 2 5 .1 0 Cumulus clouds are often found as individual towering white clouds separated from each other by expanses of blue sky. Is it because his feet are wet—as in how no
harm occurs when you briefly touch a hot clothes iron with a wetted finger? Evaporite minerals precipitate out of solution as water evaporates. Review the concept of electronegativity in Section 15.6, and rank these elements from the weakest to strongest reducing agent: (a) chlorine, Cl; (b) sulfur, S; (c) sodium, Na. 50. We expect a hot pan to cool,
just as we expect hot gases to come out of an exhaust pipe. (b) Middle clouds: altostratus, altocumulus. So there is more surface area on a bunch of small pieces of uranium than on a large piece. Although the actual mechanism of this transformation is more complicated than depicted here, the idea that new materials are formed by the rearrangement
of atoms is accurate. Will the time to hit the floor depend on the speed of the ball as it leaves the table? Suppose you balance a 2-kg ball on the tip of your finger, which has an area of 1 cm2. This may not be noticeable Blood, because it is a suspension, can be centrifuged into its components, which include the blood plasma (a yellowish solution) and
white and red blood cells. In rescuing shock victims, the first thing to do is remove them from the source of the electricity. (a) (b) (c) 51. Is the following label on a household product cause for concern? If the Moon blew up, why wouldn't we hear the sound? (b) at right angles to g. It is currently thought that most, if not all, large galaxies contain
central mega-sized black holes. Bartlett, who strongly asserts, "The greatest shortcoming of the human race is man's inability to understand the exponential function." See Professor Bartlett's still-timely article, "Forgotten Fundamentals in the Energy Crisis" (American Journal of Physics, September 1978) or any of his revised articles on the web. This
was a monumental discovery, but Hubble didn't stop there. Pressure at the same in both the pond and the lake. ISBN 978-0-321-75334-2 1. 5 Summar y of New ton's Three Laws for Isaac Newton, who was born shortly after Galileo's death in 1642. When radiation is sufficient to kill cells, the dead cells can be replaced by new ones.
Why should you find another tutor? Although a twice-as-heavy ball strikes the ground first, it falls only a little faster, not twice as fast, which is what followers of Aristotle believed. (c) They both arise from the vast voids of space between superclusters. Four concentric rings have been known for many years, and spacecraft missions have detected
many others. We find that the observable universe is flat. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Alpha particle A subatomic particle consisting of the combination of two protons and two neutrons ejected by a radioactive nucleus. The majority of the granitic magma does not
erupt but solidifies underground to form intrusive plutonic rock—granite. The successes of Newton's ideas ushered in the Enlightenment. CHAP TER 26 THE SOL AR SYSTEM 711 Venus, Earth, and Mars—are solid and relatively small and dense. A cat can hear sound frequencies up to 70,000 Hz. Bats send and receive ultrahigh-frequency squeaks up
to 120,000 Hz. Which animal hears sound of shorter wavelengths: cats or bats? It may seem that we get something (energy) for nothing simply by increasing the number of loops in a coil of wire, but we don't. Sromovsky and P. (b) Graphite has an open, layered structure and is a very soft mineral. See also Dipoles configuration of, 491 conformations
of, 491 counting by mass, 430-432 as ions, 371-372. That's why we find only two elements, hydrogen and helium, in the first period (Figure 12.30). The only way you know that you're moving eastward is because things outside your window give the appearance of moving westward. From current = voltage/ Reg R1 R2 R3 Rn resistance, we get
resistance = voltage/current = (120 V)/(20 A) = 6 \(\frac{1}{3}\). Or what if we saw a diver fly out of the water and rise upward to the diving board? In its place are new substances having completely different physical properties. The sudden increase in pressure is much the same in effect as the sudden expansion of air produced by an explosion. What are the two
main approaches to building nanoscale materials and devices? (d) not enough information to say 9. Over the past * Theoretically, the lithosphere has zero thickness at the exact location of the divergent boundary and the asthenosphere is at the surface. The star closest to our Sun, CHAP TER 27 Proxima Centauri, is about 4.2 light-years away.
Consider a water pipe that branches into two smaller pipes. Mass The quantity of matter in an object. When the central temperature reaches about 10 million K, hydrogen nuclei begin fusing to form helium nuclei. One thing interacts with the stake, and you interact with the cart. Astrology, by contrast, relies on
non-confirmable anecdotal evidence and, though very popular, has not changed significantly over the past hundred years. A nuclear power plant "meltdown" occurs when the fissioning nuclear fuels are no longer submerged within a cooling fluid, such as water. Impure (mixture) Compound Salt, NaCl Carbon dioxide, CO2 Ammonia, NH3
Homogeneous mixture Solution Air (N2, O2) Salt water (NaCl, H2O) White gold (Au, Pd) Heterogeneous mixture Sand in water Oil and water Sand in water Sand in water Sand in water Sand in water Oil and water Sand in water Sand in
radio waves are measured in megahertz. Air is transparent to both infrared (long) waves, unless the air contains excess water vapor and the gas accompanying it exert an outward pressure called thermal pressure on the contracting
matter. The time t it takes for any ball to hit the floor would be the same as if it were dropped from rest a vertical distance y. Should the string be loosened or tightened? Coal is composed of organic matter rather than minerals. If your jump lacks sufficient force, you end up in the water. Sometimes naturally occurring mixtures are labeled as being
pure, as in "pure orange juice." Such a statement merely means that nothing artificial has been added. After you have given the contemplation. Mixing red and green paint certainly does not produce yellow, so the rule for adding colored lights doesn't
apply here. Violet is dispersed by drops that form a 40° conical surface; red is seen from drops along a 42° conical surface, with other colors in between. Because of the randomness of electron motion, however, at any given moment the electrons in an atom or a nonpolar molecule may be bunched to one side. The early Greeks called it the "milky
circle" and the Romans called it the "milky road" or "milky way." The latter name has stuck. So how was Hubble able to measure the distances to incredibly distant galaxies? But in science, a fact is generally a close agreement by competent observers who make a series of observations about the same phenomenon. The crater extends 1.2 km across
and reaches 200 m deep. d, 5. (Interestingly enough, unlike humans, bees and many insects can discern polarized light, and they use this ability for navigation.) 95. Is kinetic energy conserved? Which lose(s) kinetic energy and which gain(s) kinetic energy enough, unlike humans, bees and many insects can discern polarized light, and they use this ability for navigation.)
solution of salt in vinegar, the copper (I) oxide acts as a base and reacts with the vinegar to form copper salts. The electrical repulsion between the alpha particle and the protons of the nucleus, however, is still significant. (d) not enough information to say 10. * Not all partial tones present in a complex tone are integer multiples of the fundamental.
The vibrations are then parallel to the direction of energy transfer. LEARNING OBJECTIVE Discuss how a catalyst can speed up a chemical reaction, using the destruction of stratospheric ozone as an example. The rings are composed of chunks of frozen water and rocks, believed to be the material of a moon that never formed or the remnants of a
moon torn apart by tidal forces. And as magma rises through the overlying continental crust melt and are mixed into the magma, which also increases the silica content. It appears in the form of electromagnetic waves from the Sun, and we feel it as thermal energy; it is captured by plants and binds molecules of
matter together; it is in the foods we eat, and we receive it by digestion. Safer lithium phosphate iron batteries are used for hybrid cars, such as the popular Toyota Prius shown in Figure 18.26. What is meant by the expression "You can never change only one thing"? Gyre A circular or spiral whirl pattern, usually referring to very large current
systems in the open ocean. Interestingly enough, this distance doesn't depend on the angle of the cannon. 51 A vertically plane-polarized plane wave and a horizontally plane-polarized plane wave. In the future, watch for new kinds of polymers with a wide range of remarkable properties. The chemical industry depends on catalysts because they lower
manufacturing costs by lowering required temperatures and by providing greater product yields without being consumed. The gain of oxygen, therefore, is oxidation (loss of electrons), while the loss of oxygen is reduction (gain of electrons). Another fact about rainbows: A rainbow always faces you squarely. Calcium ions and fluoride ions then join to
form the ionic compound calcium fluoride, CaF2, which occurs naturally as the mineral fluorite. When "how long" means time, we refer to the quantity force * time as impulse. The source region in which an air Source region in which are the source 
conservation of momentum, momentum, momentum, momentum (Judy + Atti) (15 kg)(3.0 m/s) = (40 kg + 15 kg)v v = 0.8 m/s 57. This vertical distance is independent of what's happening horizontally. The heat of fusion Lf for water is 80 cal/g. Under the pressure of the overlying sediments, tiny oil droplets are squeezed out of the
source rocks and into overlying porous rocks. LEARNING OBJECTIVE Describe the requirements that must be met in order for a chemical reaction to occur. Figure 20.4 shows the current composition of Earth's crust. For the same force, why does a longer cannon impart more speed to a cannonball? FIGURE 1.20 CHECKPOINT A hungry mosquito
sees you resting in a hammock in a 3-m/s breeze. Can an undernourished person perform extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion? With such intensified nuclear fusion? With such intensified nuclear fusion extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion? With such intensified nuclear fusion extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion? With such intensified nuclear fusion? With such intensified nuclear fusion extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion? With such intensified nuclear fusion extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion? With such intensified nuclear fusion extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion? With such intensified nuclear fusion extra work without extra food? 13.7 Nuclear Fusion EXPLAIN THIS N How does the energy of gasoline come from nuclear fusion extra fusion ex
Both compressions and rarefactions travel parallel to the Slinky. Molecules flying away from the liquid surface would be slowed by the attractive force of the solution, not the volume of the solvent. Although fission has been
successfully producing electricity for a half century, disposing of radioactive wastes in the United States remains problematic. The temperature rises to the point that the solid nuclear fuel, and the reaction vessel itself, melt into a liquid phase that has the potential of penetrating through the floor of the containment building. Voltage produces current
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(if there is a complete circuit). An occluded front forms when a cold front overtakes a warm front, or vice versa. But it hasn't been. From a chemist's point of view, amount typically means the number of molecules, and so water is the solvent in this case. The resulting strain is the sliding of one slab of rock past the other in opposite directions, without
any noticeable shortening or extension. The major layers of Earth are the crust, mantle, outer core, and inner core (Figure 21.1). Every gram of water that freezes releases 80 cal of thermal energy to the cellar. Otherwise the harmful cosmic rays bombarding Earth's surface would be much more intense. There is no contradiction when the mass-
energy equivalence (see Chapter 13) is understood. 574 PARTTHREEEARNING OBJECTIVE Describe how stress forces affect rock and how related strain is seen at Earth's surface. Suppose that an object in free fall were somehow equipped with a speedometer. Hence, recharging is an energy consuming process. A typical
thermonuclear bomb stockpiled by the United States today, for example, is about 1000 times as destructive as the atomic bomb detonated over Hiroshima at the end of World War II. Three lamps are connected in series with a battery. Just prior to cosmic inflation, the material of the universe was compact enough so that differing temperatures could
equilibrate. Pure water is an example of a neutral solution—not because it contains so few hydronium or hydroxide ions, but because it contains equal numbers of these ions. (a) What is the momentum of the ball just before hitting the guardrail? The person in the middle weighs 500 N, and the tension in each rope is 400 N. Why don't the planets crash
into the Sun? No; to be groundwater, all open pore spaces must be completely filled with water. If air resistance can be neglected, and if your downward initial speeds are the same, how do the speeds 110. The pressure-gradient force drives air inward toward the center of the low, but the Coriolis force deflects the wind to the right. When
a satellite is above Earth's atmosphere, is it also beyond the pull of Earth's gravity? For example, when hard water to form solid compounds, like those shown in Figure 16.24. You'll not only learn more; you'll enjoy learning more.) 1. When is it
okay to sacrifice the lives of animals for scientific research? If you can't move it, you can't do work on it. The reason—all the water mains had burst and broken during the earthquake, so there was no water to put out the fires! FIGURE 21.27 Most transform boundaries occur in ocean basins where they offset oceanic ridges—for example, the Mid-
Atlantic Ridge. Energy leaving water (cooling) 100°C Energy entering (
of solute per liter of solution. This question led to the discovery of an attraction called the strong nuclear force, which acts between all nucleons. The greater the jostling and tablets for disinfecting, however, are not always available. So the average
kinetic energy, and thus the temperature, increases by half as much. Divide by 1000 to get about 30,000 km. This supernova occurred in a galaxy 190,000 light-years from Earth. upward again, you have to provide additional impulse. Does it make a difference? Atoms on opposite sides of the periodic table have great differences in electronegativity,
and hence the bonds between them are highly polar—in other words, ionic. Carbon-14 dating would be an extremely simple and accurate dating method if the amount of radioFIGURE 13.20 active carbon in the atmosphere had been constant over the ages. How much work is done on a 200-kg crate that is hoisted 2 m in a time of 4 s? Who first
proposed that electrons exhibit the properties of a wave? C H A P T E R 18 REVIEW 485 T H I N K A N D S O L V E (M AT H E M AT I C A L A P P L I C AT I O N) 38. For both the marbles and the molecules, however, the total energy of the system before and after contact is the same. FIGURE 16.6 At the southern end of San Francisco Bay are areas
where the seawater has been partitioned off by earthen dikes. You can see such an explosive event by using the keywords "mouse trap chain reaction" for an Internet video search. The same voltage V is impressed on each of the branches of a parallel circuit. In Figure 9.21 we see the principle of the electric motor in bare outline. For instance, the
atomic mass of carbon is 12.011 amu, which means that 1 mole of carbon has a mass of 12.011 g, and we say that the molar mass of carbon is 12.011 g, and we say that the molar mass of carbon has a mass of 12.011 g, and we say that the molar mass of carbon is 12.011
H Ammonia molecule, NH3 (a) Before bonding H H H C H H C H H C H H C H H C H H C H A P T E R 15 H O W ATO M S B O N D A N D M O L E CU L E S AT T R AC T 379 FIGURE 15.20 The crystalline structure of diamond is nicely illustrated with sticks to represent the covalent bonds. If continental crust is so much thicker than oceanic
crust, why are the ocean basins underwater and the continents high and dry? 3m 250 N 500 N FIGURE A.7 No rotation is produced when the torques balance each other. What is different about the magnets compared with those of bar magnets? Why don't equal masses of carbon atoms and oxygen molecules contain the
same number of particles? Then you leap upward from the scale. 4 Just as a sound wave can force a sound receiver into vibration, a light wave can force the electrons in materials into vibration. A high voltage means a lot of energy only if a lot of charge is involved. CHAPTER 8 8.1 S TAT I C A N D CU R R E N T E L E C T R I CI T Y Electric Charge
EXPLAIN THIS What is meant by saying that electric charge is conserved? Show that the barge floats 4 cm deeper. What type of weather has been happening where you live? A society that accepts no risks receives no benefits. If we are made of stardust, what are stars made of? The sign is a joke. As the ocean off the coast of San Francisco cools in
the winter, the lost heat warms the atmosphere it comes in contact with. When the incline is vertical, S becomes equal to the weight, and the object attains maximum acceleration, 9.8 m/s2. Feldspar makes up more than 50% of the Earth's crust. When a 60-N force pushes one end of the lever down 1.2 m, the load rises 0.2 m. With the mirrors at right
angles, look at your face. The base accepted the hydrogen ion, H+, and S-19 thus gained a positive charge. Another is the cooling system of an automobile. You should understand, however, that in a 5-g sample of carbon, 3 g of carbon is available for reacting. Because the volume of water flowing through a pipe of different cross-sectional areas A
remains constant, speed of flow v is high where the area is small and low where the area is large. It will become an Earth satellite if the curve it makes (a) matches the curve of Earth's surface. Bohr reasoned that because light energy is quantized, the energy of an electron in an atom must also be quantized. A fuel cell does the opposite—hydrogen
and oxygen enter the fuel cell and are combined to produce electricity and water. Interestingly, a thousand years from now Polaris will have drifted from this unique position due to its intrinsic motion, which is its motion relative to other stars as it orbits around the Milky Way galaxy. When you speak, molecules in air propagate the disturbance
through the air at about 340 m/s. Beyond iron, the process reverses itself as nucleons have progressively more and more mass in atoms of increasing atomic number. The Conceptual Physical Science Practice Book, our most creative work, guides your students to a sometimes computational way of developing concepts. Rather, we jump from one
observable universe to the next, which gives the appearance of moving through time. 107. Scientists of the early 20th century believed that oceans and continents were geographically fixed. If the volcanic glass obsidian is not considered a mineral, why is it considered a mineral, why is it considered a moving through time. 107. Scientists of the early 20th century believed that oceans and continents were geographically fixed. If the volcanic glass obsidian is not considered a mineral, why is it considered a mineral, why is it considered a mineral fixed. If the volcanic glass obsidian is not considered a mineral fixed fixed
carbon dioxide molecule, CO2? Overall, there is one sodium ion for each chloride ion, but there are no identifiable sodium-chloride pairs. on the Moon? At any given time, about 1800 thunderstorms are in progress in Earth's atmosphere. Charts of this periodic movement became some of the first calendars. Projectiles Launched Horizontally Projectile
motion is nicely analyzed in Figure 4.14, which shows a simulated multiple-flash exposure of a ball rolling off the edge of a table. Distinguish among these characteristics of a wave: period, amplitude, wavelength, and frequency. Just as water pressure is caused by the weight of air. Production
rates for all nonrenewable resources decrease sooner or later. Now explain them in terms of Newton's third law. 1 Rain is acidified as it falls through the air. See your instructor for a more rigorous explanation, which involves momentum conservation. Because Earth's mass, m, and G don't change either, the force, F, holding Earth in its orbit does not
change. During their bumping, some molecules gain kinetic energy while others lose kinetic energy. No; tides are caused by differences in gravitational pulls. Downward? For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Atomic mass The mass of an element's atoms listed in the
periodic table as an average value based on the relative abundance of the element's isotopes. What happens to the current in the beta-carotene structure shown. Relate wave speed and bending to the phenomenon of refraction. How would an inverted
water-filled bottle empty if you tried this on the Moon? It is finely layered and has the ability to split into thin flakes parallel to the depositional layers. force of zero? A downside to separating hydrogen from carbon compounds is the unavoidable production of carbon dioxide, a greenhouse gas. When a mirror image of a sound signal combines with the
sound itself, the sound is canceled. (Note that the convention is to write the catalyst above the reaction arrow.) Before the fall of the Soviet Union, numerous oil-drilling sites in Siberia were allowed to vent natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the atmosphere, presumably because the natural gas freely into the natural
is the reversibility of the oxidation and reduction reactions. Hewitt (top) Richard Megna/Fundamental Photographs, NYC (a, b) Richard Megna/Fundamental Photographs, NYC Fred Myers, Photographs, NYC Fred Myers, Photographs, NYC (a, b) Richard Megna/Fundamental Photographs, NYC (a, b) Richard Megna
the same at any other part. This is then steady growth—the number of bacteria grows exponentially with a doubling time of 1 minute. In the collision-coalescence process, tiny droplets coalesce to form a range of droplet sizes. The frequency of its vibrating
source. Hydroxide ion A polyatomic ion made by removing a proton (hydrogen ion) from a water molecule. As the newly formed helium seeps toward the surface, it becomes concentrated within natural gas deposits. Wave speed = frequency * wavelength R E A D I N G C H E C K Q U E
STIONS (COMPREHENSION) 10.1 Vibrations and Waves 1. When it is held 1 m above ground, then relative to the ground it has a PE of 1 J. Cooking is speeded up by the circulation of heated air. FYI FIGURE 20.27 The red and orange colors in the sedimentary rocks at Bryce Canyon in Utah are caused by the presence of iron oxide. An ionic crystal
is composed of a multitude of ions grouped together in a highly ordered three-dimensional array. (Note that the units kg # m/s and N # s are equivalent.) (c) In accord with Newton's third law, the force of the ball on the padded guardrail is equal and oppositely directed to the force of the guardrail on the ball. Brushes convert the ac to dc. Hewitt Don
Hynek/Paul G. A biological cell is microscopic, as is the detail on a dragonfly's wing. (a) 4.8 W (b) 14.5 W (c) 30 W (d) none of these Answers to RAT 1. When you double the distance between a pair of charged particles, what happens to the force between them? (b) decreased atmospheric pressure. In fact, organic chemicals are the only things we eat,
except for some important minerals, such as the ions of sodium and calcium. H H Nitrogen attracts three additional electrons and thus can form three covalent Bonds Spectroscopic studies of interstellar dust within our galaxy have revealed the presence of more
than 120 kinds of molecules, such as hydrogen chloride, HCl; water, H2O; acetylene, H2C2; formic acid, HCO2H; methanol, CH3OH; methyl amine, NH2CH2CO2H. At speeds above some critical point, however, the flow may become chaotic (called turbulent flow) and follow changing,
curling paths called eddies. Remember—fault surfaces are irregular and not all movement is at the same time. Consider the exaggerated examples of two planetary bodies in parts (a) through (e) in Figure 2.20. Because of Earth's shadow, the partially eclipsed Moon looks like a cookie with a bite taken out of it. As the mass of the system (glass plus
water) increases, its natural frequency decreases. Pascal's principle A change in pressure at any point in an enclosed fluid at rest is transmitted undiminished to all points in the fluid. The cloud began to collapse under the influence of gravity. Use the shell model to explain why a lithium atom, Li, is larger than a beryllium atom, Be. D I S C U S S I O N
Q U E S T I O N S (E VA LUAT I O N) 84. pH = - log[H3O+] Solution: SAM PLE PROBLEM 1 Solution: = -(-3) = 3 SAM PLE PROBLEM 3 What is the logarithm of 105? We can see in Figure 27.2 why the background of stars varies throughout the year. relationship of the warm, cold, and dry conveyor belts to fronts The cold conveyor belt blows in low
from the east, north of the warm front. Brightness L ATE R A L I N H I B ITION Questions to ponder: Is the way in which we sometimes make judgments about other cultures and other people? The Sun's surface is a layer of glowing 5800 K plasma, which is
much cooler than the Sun's core but hot enough to generate lots of light. One of the most common sulfate detergents is sodium lauryl sulfate, a main ingredient of many toothpastes. mirror is as if your twin stood behind a pane of clear glass at a distance as far behind the glass as you are in front of it. Yes and no. Whenever we watch a sunset, we see
the Sun for several minutes after it has sunk below the horizon (Figure 11.22). We don't move through time. If it did, an HCl molecule would come along and quickly give one right back. Honesty, so important to the progress of science, thus becomes a matter of self-interest to scientists. Standing waves are set up in the strings of musical instruments
when plucked, bowed, or struck. This is accomplished in a generator or alternator by periodically switching the sign at the terminals. If the Sun is seen as a crescent. Which generally expands more for an equal increase in temperature: solids or liquids? Silicon is essential for the computer
industry in making microchips. When you stir sugar into water, the sugar crystals disappear, but where do they go? Because magnesium is a group 2 element, you know a magnesium atom must lose two electrons to form a Mg 2+ ion. Note from the periodic table how germanium, Ge (atomic number 32), is closer to the metals than to the nonmetals
Ironically, natural transmutations were going on all around them. The same type of density segregation occurs in a mixture of oil and water. Because a beta particle is an electron, the atomic number of the resulting nucleus is increased by 1. The re-emitted light is said to be scattered in all directions. The submerged part appears closer to the surface
than it actually is. 4.5 Projectile Motion 16. In this case, the distance is one wavelength and the time is one period, so the speed of a wave = wavelength/period. What is the acceleration of an object in free fall at Earth's surface? Its melting point is 97.5°C, and it reacts violently with water. Put differently, if a baseball were the size of Earth, one of its
atoms would be the size of a Ping-Pong ball. If you heat the liquid, it vaporizes and becomes a gas. A s was discussed earlier, it is impossible to obtain 100% pure water. The outer electrons of atoms in metals are not bound to any particular atom. (d) All are correct. They are energized when a voltage difference exists across different parts of your
body. A rivet is a small metal cylinder, rounded on one end and blunt on the other end. W hile eating, you've likely noticed that some foods remain hotter much longer than others. Ultimately, the best models of the atom are purely mathematical. Boiling, like evaporation, is a cooling process. Also, some clouds extend vertically in more than one
altitude range. Paleomagnetism The natural, ancient magnetization in a rock that can be used to determine the polarity of Earth's magnetic field and the rock's location of formation. P-waves are both reflected and refracted at that boundary, but S-waves are only reflected. Instead, these people would continue to be productive, vibrant, and perhaps
highly respected members of society. Consequently, four times the work is required to double the speed. The vapors are channeled into a downward-slanting tube kept cool by cold water flowing across its outer surface. What friction will remain after surface friction has been eliminated? A young atom and an old atom of the same type have exactly the
same chance to decay in the next equal interval of time. The explanation for the operation of such a barometer is similar to that of children balancing on a seesaw. This is the law of reflection, which holds for all angles: The angle of incidence. As with the Sun, all parts do not rotate in unison. In daily life, people are often
praised for maintaining some particular point of view, for the "courage of their convictions." A change of mind is seen as a sign of weakness. Water at 4°C will expand when it is slightly (a) cooled. For instance, when dealing with a reaction in which 1 mole of H i H bonds are broken, you'll write + 436 kJ to indicate energy absorbed, and when dealing
with the formation of 1 mole of H i H bonds, you'll write - 436 kJ to indicate energy released. We'll return to isotopic dating when we investigate Earth's dynamic interior in Chapter 21. Clearly this cannot continue! The consumption of a nonrenewable resource cannot grow exponentially for an indefinite period, because the resource is finite and its
supply finally expires. This layer, called the photosphere (sphere of light), is about 500 km deep. If your friends don't understand this, could you explain it to them? Each hair is repelled by others around it—evidence that like charges repel. If the planes weren't tipped, eclipses would occur monthly. A further turn from his work in science was his
appointment as warden and then as master of the mint. Interestingly, the jet is angled toward us. Interestingly, her left-andright axis is no more reversed than her up-and-down axis. Then the shadow of the Moon falls on part of Earth. Energies transform to other forms; momenta do not. No. 11.5 Color EXPLAIN THIS Why do red, green, and blue
combine to make white on your TV screen? Escape speed that a projectile, space probe, or similar object must reach to escape the gravitational influence of Earth or of another celestial body to which it is attracted. Condensation is the change of phase from vapor to water. Rank the following stars in order of increasing radius: Surface
temperature (K): Luminosity (solar units): Star A 6,000 1 Star B 4,000 100 Star C 30,000 0.01 43. Tossed at more than 11.2 km/s (c), it escapes Earth. Atmospheric soot heats Earth's atmosphere by absorbing light while cooling local regions by blocking sunlight from reaching the ground. F I G U R E 8 .1 2 Both Lillian and the spherical dome of the
Van de Graaff generator are electrically charged. The attractive force between them is 20 N. See also Groundwater; Seawater; Surface water bottled, 417-418 crystallization in, 532-533 desalination of, 413-414 hard, 411-413 purification of, 413-414 specific heat capacity of, 153-154 surface, 599-608 thermal expansion of, 156-157 wastewater
treatment and, 418-420 Water resource residence times, 591 Water softeners, 411-413 Water tables, 593 perched, 594-595 I-7 Watts, 77 Wave(s), 238-263 amplitude of, 239 heat, 265 interference and, 248-251 longitudinal, 242 motion of, 240-
241 ocean. This situation prevents any further migration of electrons through the wire. Substituting for R R the power and the resistance gives V = 1[(151 \text{ W})(95 +)] = 119 \text{ V}, close to 120 V.) 63. There are two main approaches to building nanoscale materials and devices: top-down and bottom-up. What kind of containers are used to contain plasmas at
temperatures of millions of degrees? You can throw away one, but of the remaining two, you must hold one in your hand and place the other in your pocket. When upper regions of the atmosphere are warmer than lower regions, which is the opposite of what normally occurs, we have a temperature inversion. Researchers are also working on
miniature fuel cells that could replace the batteries used for portable electronic devices, such as cell phones and laptop computers. By 2008, there were about 250 million. The magnets magnetize the steel strings. Alternating current (ac) acts as the name implies. The forces involved in impulses usually vary from instant to instant. Some
pseudoscientists and other pretenders of knowledge will not even consider a test for the possible wrongness of their statements. This is similar to the preceding exercise. For example, at 65 mph the car is quiet, but at 60 mph the car rattles uncomfortably. To understand this difference, we need to talk about a measure of how fast the work is done-
power. Concentration A quantitative measure of the amount of solute dissolved in a solution. In general, poorly sorted sediments traveled a long distance before
being deposited. A B F I G U R E 2 8 .1 5 Starlight bends as it grazes the Sun. So the force of attraction between a smaller sodium ion and a chloride ion. Refraction occurs when sound continues through a medium and bends. 274 PA R T O N E P H Y S I CS
YOUR EYE With all of today's technology, the most remarkable optical instrument known is your eye. (d) Planet Earth is a heterogeneous mixture. In 1945, Szilard generated a petition in which 68 of the scientists involved in the nuclear program asked President Truman not to drop the atomic bomb on a populous Japanese city, such as Nagasaki. Most
of the coal mined today is used to produce steel and to generate electricity at coal-burning power plants. Amazingly, a car powered by a hydrogen-oxygen fuel cell requires only about 3 kg of hydrogen to travel 500 km. It is recharged by flushing it with a concentrated solution of sodium chloride, NaCl. The abundant sodium ions displace the calcium
and magnesium ions (ions are exchanged once again), freeing up the binding sites on the resin. 728 PARTFOURE 26.36 Earth 5.2° B New Moon FIGURE 26.37 A total eclipse can occur only when the Moon's orbit intersects with the plane of Earth's orbit, which is the ecliptic. So
the Moon lines up with Earth in its monthly orbit. Red Orange Yellow Green Blue Violet Blue glass C H A P T E R 11 LIGHT 277 from atom to atom in the glass. The needle is not pulled toward the north side of the bowl because the south pole of the magnet is equally attracted southward. This represents the liquid phase. A baseball is tossed at a steep
angle into the air and makes a smooth parabolic path. The greater the number of loops of wire moving in a magnetic field, the greater the induced voltage (Figure 9.24). In 1960, there were about 74 million registered motor vehicles in the United States. When electrons are stripped from an object, it is left with a positive charge. Polarization is a
property of transverse waves, never longitudinal waves. The hydrogen is therefore electrically attracted to a pair of nonbonding electrons on the negatively charged atom of another molecule (in this case, another water molecule). The lower the boiling point of the hydrocarbon, the higher it travels up the fractionation tower. Each unpaired electron
then joins with an unpaired electron of a neighboring carbon atom to form a new covalent bond that links two monomer units. Melting of the polar ice caps can cause a rise in sea level. 1 1. LEARNING OBJECTIVE Relate the speed of electrons in a circuit to dc and ac. To produce a longitudinal wave, shake a Slinky to and fro along the direction of its
length to create a series of compressions and rarefactions. The first and oldest stars were composed of hydrogen and helium because those were the only elements available at that time. Between flaps, their wings make semicircular motions to create lift. (c) wavelength. The Voyager 2 spacecraft first visited this planet in 1986. 543: (middle) Dorling
Kindersley 543: (bottom a, b, c) Shutterstock 543: (bottom d) Dorling Kindersley 546: NASA 547: (c) Photo Researchers, Inc. FYI CHECKPOINT Both Lillian and the dome of the Van de Graaff generator in Figure 8.12 are charged. By convention, the coefficient 1 is omitted so that the above chemical
equations are typically written C(s) + O2(g) h CO2(g) 2 H2(g) + O2(g) h CO2(g) 2 H2(g) + O2(g) h CO2(g) h CO2(g
now higher than the hydronium-ion concentration, the solution is basic. If all the molecules of a body remained part of that body, would the body have any odor? We certainly don't want to follow its course. For social and political simplicity, should all phthalates be banned or just the ones shown to be harmful? Which of the three orientations of the
Moon at sunset is most correct? Fossils are the remains of ancient life and are used to interpret Earth's geologic past. (b) become radioactive. Instead, gravity is the effect we witness when a large mass—such as a planet, star, or galaxy—causes a curvature in the shape of the spacetime in which it resides. Show that the primary coil has five times as
light. LEARNING OBJECTIVE Relate the weight of the air above us to atmospheric pressure. This shorthand notation compiles 18 categories of data into a very small moisture in it condenses into clouds. (d) 42 billion years old. (b) Neutrons spontaneously decay into protons and electrons. If you pour enough of this solution into an empty laboratory
flask to make the flask contain 5 g of the solute, how many liters of the solution have you poured into the flask? It was Newton's laws that got humans to the Moon. (d) convolutes back to a stationary front. FYI 744 PA R T F O U R ASTRONOMY F I G U R E 2 7.1 0 106 Supergiants 105 104 Giants 103 Luminosity (solar units) The H-R diagram shows a
star's surface temperature on the horizontal axis and its luminosity on the vertical axis. Table 12.1 summarizes the basic facts about electrons, protons, and neutrons. Regional metamorphism is the alteration of rock by both heat and pressure over an entire region rather than just near a contact between rock bodies. F I G U R E 1 7.1 6 17.5 Energy
and Chemical Reactions EXPLAIN THIS A What changes during a chemical reaction? Re-focus to some 4500 years ago and see the building of the Egyptian pyramids. What did inflation do to the quantum fluctuations found within the early universe? After the balance was put in equilibrium, a 6-ton lead sphere was rolled beneath the mercury flask.
Even the wind, caused by unequal warming of Earth's surface, is a form of solar power. When we compare water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with atoms in a metal, we find many more ways for water molecules with a metal water molecules water molecules water molecules with a metal water molecules water molecules
misleading? The answer: the average kinetic energy of molecules left in the liquid decreases. 42 (a) Two nonpolar methane molecules are attracted to each other by induced dipole-induced dipole attractions, but there is only one attracted to each other by induced dipole attractions, but there is only one attracted to each other by induced dipole attractions, but there is only one attracted to each other by induced dipole attractions, but there is only one attracted to each other by induced dipole attractions, but there is only one attracted to each other by induced dipole attractions, but there is only one attracted to each other by induced dipole attractions, but there is only one attracted to each other by induced dipole attractions.
many homes it serves. Spacetime The continuum in which we live, consisting of three dimensions of space plus the fourth dimension of time. 2 0 Short-wavelength radiation from the Sun is transmitted through the glass. We know, for example, that there are more than 100 different types of atoms, and they are listed in the widely recognized periodic
substance is its tendency to change into another substance. Cars that remain plugged in during the day would be available to contribute energy back into the grid during peak demand—and owners of such cars could receive rebates for this energy. How deep is the water if the time delay of the echo from the ocean floor is 2 s? Himalayas, the highest
mountain range in the world. (c) radiates well. U 238 234 Th 230 Th Po Atomic mass 214 U-238 decays to Pb-206 through a series of alpha and beta decays. Exosphere The fifth atmospheric layer above Earth's surface, extending from the thermosphere upward and out into interplanetary space. (a) none (b) one (c) two (d) three 3. What is the force of
air resistance on the jet? The atomic nucleus is at the center of the atom. You can't cancel a force on the apple. The most widespread assumptions are often the least questioned. As its speed increases, its rate of 600 vibrations per second, which produces the atom.
annoying 600-Hz buzz. (Circuits 1 and 2 are "short circuits" and will quickly drain the cell of its energy. (a) 5.5 moles (b) 5.0 moles (c) 2.5 moles (d) 1.5 moles 8. The solution is to remove the CFCs that destroy the ozone. Can you figure out why? C H A P T E R 12 72. This apparent polar wandering suggested that it was the continents that moved and
not the poles. Light undergoes reflection (properly called specular reflection). Reason gave way to religion, which ushered in what came to be known as the Dark Ages. Strictly speaking, some friction does act, so it is close to being in equilibrium. A cyclotron is a device for accelerating charged particles to high speeds as they follow an expanding
spiral path. Hewitt 53: Lebrecht Music and Arts Photo Library / Alamy 59: Paul G. Aha —evidence that each experiences the same amount of force! Simple Rule for identifying action and Reaction There is a simple rule for identifying action and Reaction There is a simple rule for identifying action and reaction force! Simple Rule to Identify Action and Reaction There is a simple rule for identifying action and reaction force! Simple Rule to Identify Action and Reaction There is a simple rule for identifying action and Reaction There is a simple rule for identifying action and Reaction There is a simple rule for identify Action and Reaction There is a simple rule for identifying action and reaction force!
Americans lack a basic understanding of basic concepts of science. It undergoes constant acceleration. Most important, predict what will happen before you initiate collisions. Plastic flow in the mantle takes the form of slowly moving convection currents— hot material rises, cools, and then sinks (Figure 21.7). Figure 12.20a, for instance, shows a
large-scale physical model of a microorganism that a biology student uses to study the microorganism's internal structure. 6 Support Force 1. Half of the light gets through the first filter, and all of that light gets through the second. Its horizontal speed at the top of its path is lower than its horizontal speed when the ball leaves the bat, so it covers
less ground while falling than while rising. Likewise, if you put an ice cube into a clear glass of hot water, you can see ripples as the cold water from the melting ice cube descends in the glass. Hewitt David J. The part of the mirror above and below your line of sight to your image isn't needed, as the sketch shows. A rotating object has an "inertia of
rotation." Recall, from Chapter 3, that all mov- v r m ing objects have "inertia of motion" or momentum—the product of mass and velocity. Third, make a rectangle whose diagonal is the given vector. An old remedy for separating a pair of nested wedgedtogether drinking glasses is to run water at different temperatures into the inner glass and over
the surface of the outer glass. Add a small pinch of washing soda, which contains sodium carbonate, Na2CO3. The equation d = 12 gt 2 is most appropriate. What happens to its temperature? This is unusual because methane decomposes fairly rapidly, which tells us that this compound is currently being produced. So when we say that light from a
rose petal is red, in a stricter sense we mean that it appears red. Magma generation at divergent boundaries is very near the surface, so basaltic magma moves upward unimpeded. Sandstones are classified into three types, based on their mineral makeup. Use this information to show that atomic mass of carbon shown in the periodic table, 12.011
amu, is correct. Holding onto this negative charge isn't easy, especially when there are positively charged hydrogen ions, H + , floating about ready to combine with this negative charge isn't easy, especially when there are positively charged hydrogen ions, H + , floating about ready to combine with this negative charge. If the beam sweeps over Earth, we detect its pulses. Coffee and tea are decaffeinated using carbon dioxide in a fourth phase of matter known as a supercritical fluid
The net force acting on an object and the resulting acceleration are always in the same direction. ** Electrons, of course, are not really connected by springs. As the ice melts, rock debris is left behind and is deposited. One lunar phase cycle takes 29.5 days. Elements are listed in the periodic table in order of increasing atomic number. In the
laboratory, however, chemists work with bulk quantities of materials, which are measured by mass. What is the formula mass of sulfur dioxide, SO2? This concept is illustrated in a drawing by Newton (Figure 4.27). How does this force vary for the case in which the barbell is accelerated upward? 5.9 Bernoulli's Principle 28. Our present environmental
concern is that increased levels of carbon dioxide and gases such as methane in the atmosphere may further increase the temperature and produce a new thermal balance unfavorable to the biosphere. Both would have an effect on the curvature of the observable universe. This is because the fatigued cones send a weaker signal to the brain. A fully
charged battery thus contains an abundance of nickel hydride. That's why it takes so long for mountains to weather away. F I G U R E 1 .11 Burl Grey, who first introduced the physics author to tension forces, suspends a 2-lb bag of flour from a spring scale, showing its weight and the tension in the string of about 9 N. 373: (bottom left) Eric Schrader,
Pearson Science 373: (bottom right) John Suchocki/Paul G. If a Mack truck and a motorcycle have a head-on collision, upon which vehicle is the impact force greater? (b) If twice the force is exerted over twice the distance, how does the resulting increase in kinetic energy compare with the original increase in kinetic energy? Thermal convection is
linked mostly to (a) radiant energy. CHECKPOINT Carbon is the only element FYI that can form bonds with itself indefinitely. It was developed in the early 20th century, when meteorologists were Cold conveyor belt limited to surface data. Give two examples of common force fields. Galileo was concerned with how things move rather than why they
move. CHAPTER 12 1. (a) alpha radiation (b) beta radiation (c) gamma radiation (d) none because all three are abundant 2. Rank the forces of attraction between each pair from greatest to least. Now repeat with only the left eye open, looking this time at the X, and the dot will disappear. Geologists used (and still use) the principles of original
horizontality, superposition, cross-cutting relationships, inclusions, lateral continuity, and faunal succession. Interestingly, combustion oxidation-reduction reactions occur throughout your body. 16.5 Soaps, Detergents, and Hard Water 14. Diamond, with its small carbon atoms and tightly packed structure, is very hard—the hardest mineral known
(see Figure 20.7a). Which moves faster from horizon to horizon: the Sun or the Moon? Increased urbanization means areas of vegetation are replaced by impervious surfaces. Invert a water-filled soft-drink bottle or small-necked jar. When the egg strikes the sagging S-3 sheet, the impact time is long and the impact force is correspondingly small. All
the radiation we receive from natural sources and from medical procedures is only a fraction of 1 rem. Comet A body composed of ice and dust that orbits the Sun, usually in a very eccentric orbit, and that casts a luminous tail produced by solar radiation pressure when close to the Sun. How are fossils used in the study of geology? Kuiper belt
(pronounced "KI-pur") The disk-shaped region of the sky beyond Neptune populated by many icy bodies and a source of short-period comets. Astrology today holds that the positions of the planets, has some influence over one's personal life. Solely the product
of human design, these polymers pervade modern living. All magnets have both a north and a south pole (some have more than one of each). The Rocky Mountains, to name a few, were formed in part by reverse faulting. COOL LEARNING OBJECTIVE Contrast
compounds with the elements from which they are created. At the contact, where the temperature is high, the water content is low. As the air mass moves down the leeward slope, it warms as it is compressed. Alpha: 1 rad * 10 = 10 rems; beta: 1 rad * 10 rems; beta: 1 ra
VIDEO: Decreasing Momentum Over a Short Time or in abbreviated notation* Ft = ©(mv) where © is the symbol for "change in." The impulse-momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations in which momentum relationship helps us analyze a variety of situations and the situation of the situatio
the trajectory is "stretched out" and hardly seems to curve at all. Hold a pocket mirror almost at arm's length from your face and note the amount of your face and hardly seems to curve at all. Hold a pocket mirror almost at arm's length from your face and note the amount of your face and hardly seems to curve at all. Hold a pocket mirror almost at arm's length from your face and note the amount of your face and note the amount of your face and note the amount of your face you can see. The smells of lemons, cinnamon, and almonds are due to the aldehydes citral, cinnamaldehyde, and benzaldehyde, respectively. The stars within a galaxy are spaced so far apart
that the collision of two galaxies is analogous to the collisions. The nuclei of atoms that make up our bodies were once parts of stars. 3 Ionic Bonds 15. Pure water is not a good conductor. Or, when your car is out of control
if you drive it into a concrete wall instead of a haystack, you're really in trouble. In general, energy is the property of a system that enables it to do work. A school bus slows to a stop with an average acceleration of -2.0 m/s2. So wavefronts near the ground travel faster than they do above. For example, more than 85 billion pounds of sulfuric acid are
produced annually in the United States, making this the number-one manufactured chemical. This translates into a relatively low boiling point for the liquid, as, for example, in molecular nitrogen, N2, shown in Figure 15.27. Why do ethers typically have lower boiling points than alcohols? This, combined with salicylic acid's stomach irritation, led
many to view the salicylic acid cure to be worse than the disease. It is the distance light travels in one Earth year. Artificial Transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators to succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators and the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators and the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators are not also as a succeed in transmutation Ernest Rutherford, in 1919, was the first of many investigators are not also as a succeed in transmutation Ernest Rutherford and the first of many investigators are not also as a succeed in transmutation Ernest Rutherford are not also as a succeed in tr
weight of the atmosphere to press the liquid up into the straws. Notably, fossil fuels are far more precious as sources of organic molecules, which, as we will discuss in Chapter 19, can be used to create medicines, clothing, automobiles, and much more. Sound waves are longitudinal, which means the vibratory motion of the medium is along the
direction of wave travel. Zoom out to the solar system circling within a galaxy that orbits neighboring galaxies within a supercluster that is one superclusters. F I G U R E 1 7.1 3 This alligator became immobilized on the pavement after being caught in the cold night air. The changes in rocks that happen as
physical and chemical conditions change are called metamorphism. Speakers are out of phase when the input wires to one speaker are interchanged (positive and negative wire inputs reversed). It takes more courage to change your ideas. Antarctic Plate C H A P T E R 21 P L AT E
TECTONICSANDEARTH'SINTERIORESSURE 1.22 We say that a body undergoes acceleration when there is a change in its state of motion. Where might the pressure in a fractionating tower be highest: at the bottom or at the top? We see that Acceleration when there is a change in its state of motion.
At this elevation, the equilibrium level, the air parcel stops rising and the condensation rate equals the evaporation rate equals represent the evaporation rate equals represent rate equals represent rate equals represent rate equals represent rate equa
What is iron forced to accept during cathodic protection? Global climate change will be explored in greater detail in Chapter 25. Ones such as those in Davies Hall in San Francisco are large shiny plastic surfaces that also reflect light. REVIEW 483 18.6 Harnessing the Energy of Flowing Electrons 19. This is part of nature's thermostat; the
evaporation of sweat cools us and helps maintain a stable body temperature. Under some conditions, large parcels of cold air sink and remain at low elevations. How much work would be required to lift a payload against the force of Earth's gravity to a distance extremely far ("infinitely far") away? Alpha, Beta, and Gamma Rays All isotopes of
elements with an atomic number greater than 83 (bismuth) are radioactive. The net flow of water is reversed. c, 5. The periods are the Cambrian, Ordovician, Silurian, Devonian, Carboniferous (Mississippian and Pennsylvanian), and Permian. Even matter itself is condensed, bottled-up energy, as set forth in Einstein's famous formula, E = mc 2, which
we'll return to in the last part of this book. The 6-V battery provides 2 V across each lamp. Remove the melted ice with a sponge. The shell model, however, is a bit more sophisticated because it incorporates the wave nature of electrons. Between us and other planets is a vacuum, and sound does not travel in a vacuum. The Suchocki dog, Sam, pants
on page 174. Most silicates also contain the rest of the eight most common elements, which include Fe, Mg, Ca, and Al, but the basic building block of all silicates is Si and O. Climate is the consistent behavior of weather over time.
heartbeat in each human body, there have always been about 10,000 naturally occurring radioactive decays. That's the water that drips. The gases in magma behave in much the same way. When our bodies begin to overheat, our sweat glands produce perspiration. The relatively low pressure that exerts the lifting force against the piston is about them.
same as the air pressure in automobile tires. Then air flows faster over the top surface for much the same reason that air flows faster in a narrowed pipe or in any other constricted region. No machine or device can put out more energy than is put into it. Within the solar system are also numerous moons (objects orbiting planets), asteroids (small,
rocky bodies), comets (small, icy bodies), and a collection of miniature planets known as dwarf planets that orbit on the outer edges of the solar system. Statement (c) is an assertion that has no test for possible wrongness. No galaxy detected so far, however, has a helium abundance of less than 25%, just as predicted by the Big Bang theory. For the
remainder of this chapter, we turn our attention to some of the details involved in the production of drinkable water and the treatment of wastewater. This increase of temperature with depth is known as the geothermal gradient. Solutions aren't always liquids, however. Muscovite forms as a layered sheetlike structure. In a circuit with n branches,
Itotal = I1 + I2 + I3 + g + In . What forces act on the book? DISCUSSIONQUESTIONS (EVALUATION) 72. Reduction Oxidation 2 H2(g) \leqslant 4 OH\geqslant (aq) 4 ep \leqslant 02(g) \leqslant 2 H2O(g) H2O ep \geqslant 01 \geqslant 01 S CUSSIONQUESTIONS (EVALUATION) 72. Reduction Oxidation 2 H2(g) \leqslant 4 OH\geqslant (aq) 4 ep \leqslant 02(g) \leqslant 2 H2O(g) H2O ep \geqslant 01 S CUSSIONQUESTIONS (EVALUATION) 72. Reduction Oxidation 2 H2(g) \leqslant 4 OH\geqslant (aq) 4 ep \leqslant 02(g) \leqslant 2 H2O(g) H2O ep \geqslant 01 S CUSSIONQUESTIONS (EVALUATION) 72. Reduction Oxidation 2 H2(g) \leqslant 4 OH\geqslant (aq) 4 ep \leqslant 02(g) \leqslant 2 H2O(g) H2O ep \geqslant 01 S CUSSIONQUESTION (EVALUATION) 72. Reduction Oxidation 2 H2(g) \leqslant 4 OH\geqslant (aq) 4 H2O(g) \leqslant 5 H2O(g) H2O(g) \leqslant 6 H2O(g) H2O(g) \leqslant 6 H2O(g) H2O(g) \leqslant 7 H2O(g) \leqslant 8 H2O(g) \leqslant 8 H2O(g) \leqslant 8 H2O(g) \leqslant 9 H2O(g) \leqslant 9
Porous graphite electrodes O2 

Relations H2O vapor C H A P T E R 18 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S Although fuel cells are similar to dry-cell batteries, they don't run down as long as fuel is supplied. As can be expected, this ability mainly depends on the submicroscopic attractions between solute particles and solvent particles. The
allowed energy levels for any atom, therefore, could be graphically represented as orbits around the nucleus, as shown in Figure 12.26. One was that heavy objects necessarily fall faster than lighter objects. The reasons for this behavior, which are beyond the scope of this book, involve quantum mechanics. Because of CHAPTER 20 R O CK S A N D M
INERALS 547 the large-scale nature of regional metamorphism, these zones tend to be broad and extensive. The tendency of silicon to bond with oxygen is so strong that silicon is never found in nature as a pure element; it is always combined with oxygen is so strong that silicon is never found in nature as a pure element; it is always combined with oxygen. New Zealand has frequent earthquakes (140,000 minor quakes a year!) and a developed
economy. Allowing students access to the text wherever they have access to the Internet, Pearson eText comprises the full text, including figures that can be enlarged for better viewing. This produces a "sound barrier," which on older aircraft caused some control problems, and on modern aircraft makes for some interesting visual effects (Figure
10.33). Acids are essential in the chemical industry. Calculate the quantity of heat needed to turn 200 g of 100°C water to steam at the same temperature. In a dress shop with only fluorescent lighting, a customer insists on taking dresses into the daylight at the doorway to check their color. Wind-blown deposits tend to be very well sorted and small
Satellites are normally sent into orbit by firing them in an easterly direction, the direction in which Earth spins. Any one region of the mixture has the same ratio of substances as any other region, and the components cannot be seen as individual identifiable entities. How did Aristotle classify motion? Infrared waves Radio waves F I G U R E 7.11 A
wave of long wavelength is produced when the rope is shaken gently (at a low frequency). Rank them in terms of the number of atoms, from most to least. Which undergoes a faster rate of cooling: a red-hot poker in a warm oven or a red-hot poker 
an intermediate between a barred and unbarred spiral (Figure 27.28). For example, salt placed on 0°C ice causes the ice to melt even though the temperature has not changed. When atoms regions of great mountain building. II.
That's 5000 N, more than his weight. Does this mean that scientists still doubt its validity? Iron is nearly eight times as dense as water, so when it is submerged it displaces only 18 ton of water, which is certainly not enough to prevent it from sinking. Because this electron has gained energy, it must move away from the nucleus. Hewitt 363: (bottom)
THIS When the Moon rises at sunset, its phase is always full. This imaginary line is called the normal. CHAPTER 17 1. (Electroscopes are useful not only as charge detectors but also for measuring the quantity of charge: the greater the charge transferred to the ball, the more the leaves diverge.) REVIEW 213 99. The zinc oxidizes to zinc oxide, an
inert, insoluble substance that protects the iron underneath it from rusting. What's the net charge of a dipole? Polarization The alignment of the transverse electric vectors that make up electromagnetic radiation. Ordinary window glass doesn't have a color because it transmits light of all visible frequencies equally well. Interestingly, this form of
minerals. 3.4 Energy and Work EXPLAIN THIS How much faster will you hit the ground if you fall from twice the height? In the United States, for example, synthetic polymers have surpassed steel as the most widely used material. Note that the left wheel slows first when it interacts with the grass on the lawn. Therefore, the formula mass of an
oxygen molecule, O2, is about 32 amu (15.999 amu + 15.999 amu). Torque = lever arm * force Lever arm is the distance between the point of application of the force and the axis of rotation. The mass of golf balls is greater than the mass of Ping-Pong balls, so a given mass contains more Ping-Pong balls than golf balls. Look now for hybrid vehicles
amount of energy it puts out per second. In Earth, density segregation led to the formation of a dense, iron-rich core, a less-dense, rocky mantle, and an even less-dense, rocky mantle, and the myriad objects in your environment, to know that they are all composed of atoms—amazing, ancient,
invisible systems of particles regulated by an eminently knowable set of laws. Show that the speed of the wave is 4.5 m/s. What are the four common phases of matter? Or the increased pressure may deform and flatten the rock, shear it, or break it and grind it into fragments. To a lesser extent, red light is also absorbed by water—enough so that it
appears a greenish-blue or cyan color. 1 FIGURE 13.7 Nuclear radiation is focused on harmful tissue, such as a cancerous tumor, to selectively kill or shrink the tissue in a technique known as radiation forces. Might plain water be used to
make this solution alkaline? Coulomb's Law EXPLAIN THIS What do the laws of Newton and Coulomb have in common? Did Bohr think of his planetary model as an accurate representation of what an atom looks like? In some rocks, the grains are tightly interlocked. A chemical equation must be balanced
because the law of conservation of mass says that mass can be neither created nor destroyed, e (a) molecule A, which is the first to transform into a liquid (b) molecule B, which remains in the gaseous phase 15 C H A P T E R 1 5 How Atoms
Bond and Molecules Attract W hy do salt crystals have a 15. Charged objects lose their charge more quickly at higher altitudes. The volume change is dramatic—from less than 0.3 L to about 170 L, which is an increase of about 600%. Static electricity is a problem at gasoline pumps. In describing oxygen's physical properties, you should have noted
that it is an invisible gas with no odor detectable over that of the yeast. Usually absorption of energy involves a combination of both. 1.31 Ca Sc 0.82 1.0 1.36 Rb Sr Y 0.82 0.95 Ti V 1.54 1.63 1.65 1.81 2.01 2.18 2.55 2.96 — Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe 1.78 1.96 2.05 2.1 2.66 — Tl Pb Bi Po At Rn 2.04 2.33 2.02 2.0 2.2 1.66 1.55 1.83
AC T 381 of the atoms in the periodic table—the farther apart they are, especially when one is at the lower left and one is at the upper right, the greater the polarity of the bond between them. Upon detonation, 1 mole of nitroglycerin, C3H5N3O9, produces 7.25 moles of gases including carbon dioxide, CO2; nitrogen, N2; oxygen, O2; and water vapor
H2O. At position 3, do the same with a 9-cm length of string. True or False: The greater the nuclear charge of an atom, the greater is the electronegativity. The crescent Moon always points toward the Sun. Even if you are incorrect in your assessment, you should be able to defend why you chose as you did. 3 1 The Cigar galaxy, M82, is a spiral galaxy
                 from us so that we see it from an edge-on view. Magnesium is on the left in the periodic table, and so atoms of this element do not hold onto the downward forces against the top, the forces do not cancel, and there is a net force upwar
Then F * d = 600 \text{ N} * 0.08 \text{ m} = 48 \text{ J}, and 48 \text{ J} = (0.006 \text{ kg})(450 \text{ J/kg} \# ^{\circ}\text{C}), which we can solve to get \bigcirc T = 48 \text{ J/}(0.006 \text{ kg} * 450 \text{ J/kg} \# ^{\circ}\text{C}) = 17.8^{\circ}\text{C}. Metamorphic rocks Rocks formed from preexisting rocks that have been changed or transformed by high temperature, high pressure, or both. How does the gravitational force on a falling body
compare with the air resistance it encounters before it reaches terminal velocity? 3 2 Gamma-ray emissions 50,000 light-years Milky Way Sun arising only several million years ago. Orographic lifting of an air mass over a topographic barrier such as a mountain. The event horizon surrounding a black hole is often called the
surface of the black hole, the diameter of which depends on the mass of the hole. (e) eddy currents. EXPLAIN THIS What is meant by "Equations are guides to thinking"? Let Newton's second law guide the answer to this: a = F/m. Now try it upside down—for example, with the paper held against a book above your head. This provides the amount of
solute required: (380 g/L)(3 L) = 1140 g. Many recent discoveries are featured in this edition, illustrating how science is more than a growing body of knowledge; it is an arena in which humans actively and systematically reach out to learn more about our place in the universe. CHECKPOINT Biological membranes, including cucumber membranes,
are semipermeable, C. A. B. What is the relative humidity of the air mass? Most of these hydrogen atoms were formed during the beginning of our universe about 13.7 billion years ago. The volume of the water displaced is 0.5 L. and the buoyant force is 4.9 N. Chemistry builds on physics by telling us how matter is put together, how atoms combine to
form molecules, and how the molecules combine to make the materials around us. What effects might a cure for aging have on the problem of overpopulation? Because of the high specific heat capacity of water, sunshine warms water much less than it warms land. But with the same punch he can exert only a tiny force on the tissue paper in midair.
What common liquid covers more than two-thirds of our planet, makes up 60% of our bodies, and sustains our lives and lifestyles in countless ways? Why do red blood cells, which means electrons mitting antenna
vibrate 940,000 times each second and produce 940inside are jiggling in unison billions of times per second! The frequency of the kHz radio waves. Thus, recycling aluminum not only reduces air pollution. Because sedimentary rocks contain the remains of organisms and
older rocks, they provide information about geological events that have occurred over time at Earth's surface. Occupants of the spaceship might be prone to attribute their observations to the force of gravity. But carbon atoms of other elements as well, further increasing the number of possible organic molecules. CHECKPOINT
Chemists have learned how to produce aspirin using petroleum as a starting material. What happens to the double bond of a monomer participating in the formation of an addition polymer? The nitrogen and oxygen molecules that make up our atmosphere, for example, are continually colliding with one another. An improved vehicle in 2000 emitted
less than 0.5 g of uncombusted fuel, less NO than 0.5 g of nitrogen oxide, and only about 3 g of carbon monoxide per mile traveled. Cosmic background radiation The faint microwave radiation that is the remnant heat of the Big Bang. To differentiate this unit and the smaller calorie, the food unit is usually called a
Calorie, with a capital C. Any charge that builds up on an appliance is therefore conducted to the ground. For example, when asked to rank quantities such as momentum or kinetic energy, students are called to use appreciably more judgment than in providing numerical answers. Without this slack, a locomotive might simply sit still and spin its
wheels. CHECKPOINT Why does a star shrink when its core runs out of nuclear fuel? He is shown again walking barefoot on red-hot coals on page 164. Thus, the two parts of the fence will be separated by 3.5 cm/yr * 20 yr = 70 cm. Torque f you sprinkle some iron filings on a sheet of paper placed on a magnet, you'll see that the filings trace out an
orderly pattern of lines that surround the magnet. As rock is heated, the first minerals to melt are those with the lowest melting points. Briefly, it involves the stability of the negative ion that remains after the proton has been donated. The number is so 118 enormous that if you could travel 1010 m in any direction, you would have a large probability
of coming across another observable universe that looks very much like the one you left. Together these add up to a four-dimensional universe of spacetime. Rocks respond different times. Repeat the preceding activity, but use 10 dimensional universe of spacetime. Rocks respond different times. They attain speeds of 100 body lengths per
second. He also recognized that any force on a planet would be directed toward a fixed central point—toward the Sun. A helium-filled balloon weighs less than the air it displaces and rises. High-mass stars, however, are more luminous than lowmass stars, meaning that they burn their hydrogen fusion fuel at a faster rate. It was the costliest natural
disaster in U.S. history. Although cumulonimbus clouds are associated with precipitation, they do not produce an overcast sky. fresh water because salt water is slightly denser than fresh water because salt water is slightly denser than fresh water. The total amount of energy released as these bonds form is - 1856 kJ. What becomes of energy when efficiency is lowered in a machine? In 1938, two
German scientists, Otto Hahn and Fritz Strassmann, made an accidental discovery that was to change the world. (c) air expands and warms. FIGURE 14.7 Two physical changes. He imagined that the mountaintop was above Earth's atmosphere, so that air resistance would not impede the motion of the cannonball. The lightbulb in the circuit therefore
remains unlit. What type of matter is visible? And clocks run slower on Mercury than they do on the Moon, which has the least mass of these three celestial bodies. It would take about one-half year to drive to the Moon traveling at freeway speeds. Alternatively, certain porous materials, including the recently developed carbon nanofibers shown in
Figure 18.29, can hold large volumes of hydrogen "sponges." The hydrogen is "squeezed" out of these materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on demand by controlling the temperature—the warmer the materials on the materials of the controlling the temperature—the warmer the materials of the controlling the temperature and the controlling the controlling the temperature and the controlling the controlling the controlling the controlling the co
LAXIES 739 LEARNING OBJECTIVE Distinguish between the diurnal and intrinsic motion of celestial objects, and express the vast distances in space in units of light-years. The FIGURE B.11 satellite picks up speed until it A-10 APPENDIX B whips around to position D (perigee), where once again the direction of motion is perpendicular to the
gravitational force, f \int blends to full F, and f is nonexistent. Your empty hand is not hurt when it bangs lightly against a wall. Water pressure at the bottom of a lake depends on the (a) weight of water in the lake. As a tree respires, it takes in carbon dioxide, CO2, and water vapor, H2O, from the air while also releasing oxygen, O2. The Brønsted-Lowry
definition of an acid and base says that an acid is any chemical that donates a hydrogen ion and a base is any chemical that accepts a hydrogen ion. Suppose you operate a 100-W lamp continuously for 1 week when the power utility rate is 8¢/kWh. Show that the cost is $1.34. The concepts of dark energy and dark matter are late-20th- and 21st-
century confirmations. 41. Brightness Brightness White light is dispersed by a prism into a rainbow-colored spectrum. Although dark energy and dark matter both begin with the word dark, they are uniquely different. Here is where the difference between force and pressure comes in. Heat radiation underlies infrared thermometers. Every form of
energy can be transformed into every other form. C H A P T E R 16 MIX TURES 415 FIGURE 16.30 Saudi Arabia is the world's leading producer of desalinized water. FYI LEARNING OBJECTIVE Identify the major properties of the four inner planets: Mercury, Venus, Earth, and Mars. One of the most common changes is an increase in crystal size due
to recrystallization. Distinguish between dew and frost. So, longer subduction zones mean faster plate movement. Plug-in hybrids with their large and highly efficient batteries offer much in the way of moving individuals and the nation as a whole toward energy conservation and independence. CHAP TER 26 Lunar eclipse The phenomenon in which
the shadow of Earth falls on the Moon, producing the relative darkness of the full Moon. The electrons are held more firmly in rubber or plastic than in wool or fur, for example. Reaction progress Reaction progress Reaction progress Reaction progress Reaction progress (a) (b) (c) 44. Whatever the shape of the submerged body, the buoyant force is equal to the weight of fluid displaced.
Whatever initial forces set the asteroids in motion are irrelevant now. (b) If the boxer moves into the glove, the time is reduced and he must withstand a greater force. The spectroscope allows us to analyze the light emitted by elements as they are made to glow. F (b) F I G U R E 8 .1 4 (a) The spring has more elastic PE when compressed. Figure 15.2
shows the electron-dot structures for the atoms important in our discussions of ionic and covalent bonds. 578 PARTH REEEARTH REEE
carbon oxidized or reduced? What is the purpose of the salt bridge in a voltaic cell? Collisions Momentum is conserved for all collisions, elastic and inelastic (whenever external forces don't interfere). Only the resilience of the human hand and the training she has undergone to toughen her hand allow this feat to be performed without broken bones.
So a = mg/m = g. 788 PARTFOUR ASTRONOMY 28.3 General Relativity 11. With carbon nanofibers, a volume of 36,000 L of hydrogen can be reduced to a mere 35 L. Why is Neptune bluer than Uranus? During the next week, we see more and more of the sunlit part. CHECKPOINT The temperature of Sirius is about 9400 K. From a long view of
human history, there can be little doubt that events such as the American Civil War will pale into provincial insignificance in comparison with the more significant event of the 19th century: the discovery of the electromagnetic laws. For example, when carbon and oxygen combine to form carbon dioxide, they always combine in the ratio of one carbon
atom to one oxygen molecule. Why would it be a bad idea to have the back of your hand up against the outfield wall when you catch a long fly ball? 494 PARTTWOCHEMISTRY LEARNING OBJECTIVE Identify the structures of unsaturated hydrocarbons. FYIFIGURE 18 To Compare the structures of unsaturated hydrocarbons.
thunderstorm. Eventually, however, a point is reached at which the weight of upper pillows such that the column of pillows gets shorter. (c) Now consider the column of pillows gets shorter.
consistent with everyday observations. Like carbon dioxide, water vapor is a powerful greenhouse gas. Is there a pattern? If the horizontal component of the cannonball's velocity is 20 m/s, how far downrange will the cannonball be in 5 s? You know that a sharp knife cuts better than a dull knife. How many atoms are there in one molecule of H3PO4?
In either case, with no acceleration, weight equals mg. After the sand dries, you've got just the sand. ESCAPESINTHESURFACEOFBODIESINTHESURFACEOFBODIESINTHESURFACEOFBODIESINTHESURFACEOFBODIESINTHESOLARSYSTEM Mass (Earth masses) 333,000 318 95.2 17.3 14.5 1.00 0.82 0.11 0.055 0.0123 Radius (Earth radii) 109 23,500 11 9.2 3.47 3.7 1.00 0.95 0.53 0.38 0.27
Escape Speed (km/s) 620 42.2 60.2 36.0 24.9 22.3 11.2 10.4 5.0 4.3 2.4 The first probe to escape the solar system, Pioneer 10, was launched from Earth in 1972 with a speed of only 15 km/s. 28, 2015 Jan. (c) both of these (d) neither of these 3. Except when they are too close, black holes shouldn't worry future astronauts. The light from our nearest
star, Proxima Centauri, takes 4.2 years to reach us. Interestingly, the human body is a significant source of natural radiation, primarily from the potassium we ingest. If you held the tip of such a glass cone against your eye, what would you see? Another 23% is composed of the yet-to-be-discovered particles of exotic dark matter. The speeds are the
same because momentum is simply transferred from one car to the other. Altogether this cluster of galaxies is called the Local Group. So after beta emission by thorium with 90 protons, the resulting element has 91 protons. Ice forms when the water temperature drops below the freezing/melting point. How is it that water and soap are attracted to
each other not only by ion-dipole attraction but also by dipole- induced dipole attraction? Nobody is exempt. Torque does, and children soon learn that the land, sky, or ocean is made of, you are thinking about chemistry. A handful of sand
and a glass of water are macroscopic samples of matter. You now see yourself as others see you. We may romanticize a better life without these, but only if we overlook the many hours of daily toil devoted to laundry, cooking, and heating homes. I took this advice. Compare results at every stage with the national average or with your previous class.
When the page is illuminated by white light, it appears white because the electrons re-emit all the visible frequencies. (b) (c) CHAPTER 20 Volcano Lava flow Sill Volcanic pipe Dike Laccolith exposed by erosion R O CK S A N D M I N E R A L S 539 FIGURE 20.22 Intrusive igneous features in cross-sectional view. When our frame of
reference is accelerated, we observe fictitious forces and motions. Alcohol produces more cooling because of its higher rate of evaporation. Since the early 1800s, astronomers measured a precession of Mercury's orbit—about 574 seconds of arc per century. 3 4 Each disk in this deep-space image taken by the Hubble Telescope is a galaxy. From best
to worst, rank these materials as heat conductors: (a) copper wire, (b) snow, and a (c) glass rod. Lucy Lightfoot stands with one foot on one bathroom scale and her other foot on a second bathroom scale. When the barrel is filled with water up to the base of the pipe (1 m deep) the water pressure on the bottom of the barrel is 9.8 kPa. What is the
pressure on the bottom when water is added to fill the pipe to its top? The valence electrons of an atom are shown in its electron-dot structure. Any material having free charged particles that easily flow through it when an electric conductor. If the clerk measures out 5 lb of red beans, how many pounds of blue
beans must she measure out? The net force on the book is zero. Energy cannot be created or destroyed. The more massive car has twice the potential energy. The height of the barrier is different from the height a jumper's "center of gravity" rises. Thus, water molecules are changed to molecules of hydrogen and oxygen, two substances that are very
different from water. A bowling ball sits at rest and another bowling ball rolls down a lane at constant speed. When ablation exceeds accumulation, the glacier retreats—it shrinks. The pressures should be approximately the same. At room temperature, potassium chromate is a bright canary yellow. What is the effect on the current in a wire if both the
voltage across it and its resistance are doubled? 20. The bulb appears to be red or pale orange, while light scattered to the side appears blue. Being an acid, hydrogen chloride donates hydrogen ions to water, forming chloride ions and hydronium ions. In it are abundant conduction electrons that flow to produce Jupiter's enormous magnetic field.
Many tongues have been injured by licking a piece of metal on a very cold day. Minerals found in rocks and in dietary supplements are similar yet different. A sample of water that is 99.999% pure. As with electric force, the electric field about a particle obeys
the inverse-square law. On a windy day, waves in a lake or the ocean are higher than their average height. The magnitudes of the forces are the same, for they constitute an action-reaction force pair that makes up the interaction between the bus and the bug. Air and ice friction forces are negligible. Assuming it takes about 100 mL of gasoline to ship
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each liter of bottled water, worldwide this would translate to about 25 million tons of carbon dioxide, not to mention other pollutants. Molecular motion slows, thus allowing molecules to bind together. How does the speed of sound in steel compare with the speed of sound in air? What is the pH after 500 mL of water is added? To match the wider

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curvature of much larger Jupiter, and to contend with Jupiter's greater gravitational pull, the cannonball would have to be fired significantly faster. With increases in temperature, liquids expand more than solids. For the highest-frequency sound, l = v/f = (340 \text{ m/s})/(20,000 \text{ Hz}) = 0.017, or 1.7 cm. How soon will nanotechnology give rise to commercia
products? Just as the ornaments give character to the tree, so do heteroatoms give character to an organic molecule. The solar core constitutes about 10% of the Sun's total volume. Sunlight Shortest path at noon as Figure 11.41 indicates, the path through the atmosphere is longer, and more violet and blue are scattered from the sunlight. His
potential energy at the top is 10,000 J. In the preceding exercise, how will your wages for only the 30th day compare to your total wages for the previous 29 days? Magnetic field The region of magnetic influence around a magnetic pole or a moving charged particle. Boyle's law The product of pressure and volume is a constant for a given mass of
confined gas regardless of changes in either pressure or volume individually, so long as the temperature remains unchanged: P1V2 = P2V2 Buoyant force that a fluid exerts on an immersed object. (d) Whether an element forms one or the other depends on nuclear charge and not on the relative positions in the periodic table. By
viewing each electron orbit as a self-reinforcing wave, we see that the circumference of the smallest orbit can be no smaller than a single wavelength. A sand mound starts moving downwind as sand grains on the windward slope move up and over the crest of the dune to fall on the leeward slope. Most sound is transmitted through air, but any elastic
substance—solid, liquid, or gas—can transmit sound.** Air is a poor conductor of sound compared with solids and liquids. In an Olympic competition, a microphone detects the sound of the starter's gun, which is sent electronically to speakers at every runner's starting block. If we say there is a force of suction, then we assume that a vacuum can exert
a force. MIX TURES 405 Would a "mole" of stacked pennies stretch across our galaxy? Cenozoic era The time of recent life, it began 65 million years ago and is ongoing. In a similar fashion, the hydrogen chloride salt of phenylephrine is made using hydrogen chloride, but it is not hydrogen chloride. This is the phenomenon of refraction. Thus, this or
any other electron transfer, because it results in the formation of a new substance, is a chemical point, known as the Lagrangian point, known as the Lagra
formed from magma that cools beneath Earth's surface. VIDEO: Image Formation in a Mirror 270 PARTONEPHYSICS Law of Reflection Anyone who has played pool or billiards knows that when a ball bounces from a surface, the angle of incidence is equal to the angle of rebound. Is Gretchen touching her dad, or is he touching her? The total
mass of the products is greater than the total mass of the fusing nuclei. The same is true for waves of wind over a field of tall grass on a gusty day. The same is done with other fossil fuels. Obsidian does not have a crystalline structure, so it is not a mineral. (b) Then show how the food value in calories per gram is 5.8 kcal/g (or 5.8 Cal/g). CHAPTER 4
4.9 G R AV I TY, PROJECTILES, AND SATELLITES Escape Speed What is your fate if you are launched from Earth at a speed greater than 11.2 km/s? 440 PARTTWOCHEMISTRY Ozone, O3 Ea 2 O3 Oxygen, O2 Energy Energy Ozone, O3 Ea 3 O2 2 O3 Reaction progress Cl 3 O2 Reaction progress (b) With chlorine
catalyst (a) Without catalyst F I G U R E 1 7.1 4 (a) The relative humidity of relative humidity is less than 100% 60%, then lowered the
temperature to 10°C? Many states offer refunds for empty containers. (b) Show that the mass of the block is 10 kg. As the rock rises, pressure on the rock decreases, lowering the melting point enough for melting to occur. If the winds at the latitude of San Francisco and Washington, DC, were from the east rather than from the west, why might San
Francisco be able to grow only cherry trees and Washington, DC, only palm trees? 106. The water remaining in the cup contains half the thermal energy that the full cup of water contained, because there are only half as many water molecules in the cup as before. As the tungsten filament is heated, minute particles of tungsten evaporate—much like
steam leaving boiling water. Under what condition can the entropy of a system be decreased? Which of these does a transformer change: voltage, current, energy, power? Her hand is not in steam, but in a jet of condensed vapor that has expanded and cooled. If FIGURE B.7 we know the magnitude and direction of the vector F, we can estimate the
magnitude of the components from the vector diagram. A PPE N DI X A Linear and Rotational Motion W HEN W E DE SCR IBE T HE MOT ION of something, we say how it moves relative to something else (Chapter 1). They are replaced by new droplets forming above. They did this centuries before the concept of zero was recognized by accountants
in India. (b) joules. Why is it placed in orbit only in the plane of Earth's equator? I will not maintain that knowledge can never do harm. (a) The dissolved ions provide a pressure that eventually bursts open the cell. The nuclear fuel is primarily U-238 plus about 3% U-235. The negative Cl- then joins the pseudoephedrine-H+ ion to form the salt
pseudoephedrine hydrochloride, which is a nasal decongestant, shown in Figure 18.6. This salt is soluble in water and can be absorbed through the digestive system. 105. FIGURE 26.6 The pink chromosphere becomes visible when the Moon blocks most of the light from the photosphere during a solar eclipse. It is actually energy of position at the
submicroscopic level. In this book, we focus on science, which is an enchanting human activity shared by a wide variety of people. Tossed slightly faster (b), it takes an elliptical orbit and returns in a slightly longer time. This dominoes chain reaction occurs on a two-dimensional flat surface. Nearby active galactic nuclei, such as that of M87, give us a
clue as to the possible nature of the most energetic galaxies of all—the quasars. 7.8 Melting and Freezing EXPLAIN THIS How can melting and freezing occur at the same time? Then suspend it at its center of gravity by a string. Does the phosphate ion, a common additive to automatic dishwasher detergent, tend to behave as an acid or a base? So, we
can speculate that while mass warps spacetime in one direction, dark energy warps it in the other. (This corresponds to 186,000 mi/s.) LIGHT 267 F I G U R E 11. Make a concentrated solution of red cabbage extract by boiling a cup of shredded red cabbage in a cup of water for about 5 minutes. Developed countries, with more resources, tend to have
better building construction, which adds to their preparedness and a speedier recovery. Focus your attention on the sound. FYI Perhaps you tried looking at Figure 12.12 to answer this question and quickly became frustrated because the sixth-period elements are not shown. But why? The arrows depict the direction of glacial movement. Hewitt Paul
G. Students are then introduced to the atomic nucleus and its relevance to radioactivity, nuclear power, and astronomy. Step 2: Place a heavy ceramic coffee mug in the center of the pot. The net force is zero in this case. Chemists are often more interested in the number of solute particles in a solution than in the number of grams of solute. Loosely
moor a pair of toy boats side by side. (5.00 g gold)(1 mole gold/197 g gold)(6.02 * 1023 atoms/ 1 mole) = 1.53 * 1022 gold atoms. Both are potato-shaped and have cratered surfaces. Therefore, the air is warmed. This separation of charge makes up a dipole. Bromine atoms are larger, and this makes the formation of induced dipole-induced dipole
attractions more favorable. They discovered that atomic oxygen effectively transforms surface organic materials into gaseous carbon dioxide. Its poles are also located at its two ends. FYI "I can live with doubt and uncertainty and not knowing. (c) The greater the electronegativity of an atom, the lower its ability to become oxidized. The chemical
reactions in a disposable battery are exothermic, as evidenced by the electrical energy they release. Rotation effectively supplies a support force and nicely provides weight. The 0°C gas has an absolute temperature of 273 K. It does not meet all the criteria needed to be a mineral. (c) zero. From Figure 13.30 we can see how energy is released when
uranium nucleus splits into two nuclei of lower atomic number. CHAPTER 4 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L I T E S 93 end of the balance to restore equilibrium. Then the acceleration will be halved. Ironically, Galileo couldn't say why all bodies fall equally because he never connected the concepts he developed—acceleration and
inertia—with force. Franklin didn't explain charge transfer in terms of transfer of electrons because electrons el
rocks in the early 1970s, we are now learning about the history of Mars and other planets from the chemical information gathered by space probes. At what other angle of launch at the same speed would this projectile land just as far away? We know helium is produced from the fusion of hydrogen in stars. Set this up as a unit conversion: (1.6 * 107
mt)(1000 kg/1 mt)(1000 g/1 kg) = 1.6 * 1013 g of aluminum (16 quadrillion) 45. Repeat this for small objects on various backgrounds. Then, in 1986, superconductivity was achieved at 30 K, which spurred hopes of finding superconductivity was achieved at 30 K, which spurred hopes of finding superconductivity above 77 K, the point at which nitrogen liquefies. = 25 turns. Two plastic bottles of fresh seltzer water are
opened. The seafloor had been growing when magnetic pole reversals occurred. Hold it at a downward angle to show a version of Figure 4.17 (right). The same goes with the universe: a galaxy twice as far away from us is moving twice as fast. We can look at this process from an atomic point of view. he Sun produces energy from the thermonuclear
fusion of hydrogen to helium. What evidence supports your answer? Should it be possible in principle for a photon to orbit a star? Glassy volcanic rocks are classified by composition as a whole (not by individual minerals). At 100C, the solubility of sodium nitrate, NaNO3, in water is 165 g per 100 mL of water. Supercritical carbon dioxide is relatively
easy to produce. From Newton's second law we know that a = (Fnet)/m. Your lab partner says, "An electron always experiences a force in an electric field, but not always in a magnetic field." If you agree with him, defend his statement. Apparently, just believing that the bracelet relieves pain does the trick! Interestingly, the brain initiates the
creation of endorphins (which bind to opiate receptor sites) when the person expects to get relief from pain. Which materials settle toward the bottom of the jar? B C A 50 kg E X E R C I S E S (SYNTHESIS) Please do not be intimidated by the large amount of end-of-chapter material in this and some other chapters. Wave speed g
frequency: wavelength g f L 41. 18.8 Corrosion and Combustion 27. (d) energy fields. You cannot touch without being touched—Newton's third law. Again, for emphasis: friction always acts in a direction to oppose motion. When the wooden block is placed in the beaker that is brim filled with water, what happens to the scale reading after water has
overflowed? This material, a yellow-green gas at room temperature, is very toxic, and it was used as a chemical warfare agent during World War I. If not, why not? Strontium, Sr (atomic number 20). This is the
Norwegian cyclone model, and it does a great job of deDry conveyor belt scribing the beginning, middle, and end of a midlatitude cyclone. This supernova occurred safely outside the Large Magellanic Cloud. For further experimentation, repeat this activity in
two pots set side by side. If you pass a compass from their bottoms to their tops, you can easily identify their poles. We double the density of air in the missing speedometer needle at t=3 s, t=4 s, and t=5 s. 6 Galaxies eye sees not more
than 3000 stars, horizon to horizon. Remember from Chapter 24 that carbon dioxide is a "greenhouse gas." By this we mean that CO2 blocks the escape of infrared radiation from Earth's surface and contributes to the warming of our planet. For most elements, such as iron, the isotopes have no special names and are indicated merely by mass
number. Lower atmospheric pressure (as at high altitudes) decreases the boiling temperature. Upon which is the buoyant force ineffective? In which direction does thermal energy flow between hot and cold objects? Many of these Think and Solve problems are couched in symbols only—with a Part b that treats numerical values. In a solution all the
components are in the same phase, whereas the components in a suspension are in different phases. For adiabatic temperature change to occur while the volume change is occurring. If the air cools to its dew point, the water vapor condenses
and a cloud forms. If too many bulbs are connected in parallel across a battery, does their brightness diminish? A typical cumulus cloud has an updraft speed of at least 1 m/s, which is faster than the droplets can fall. (b) Waves created by vibration at particular rates are self- reinforcing. The stroking motion aligns the domains. Mass. All three of these are self- reinforcing.
cases possess the same essential ingredient—a changing magnetic field in the loop. (It can.) Does the charcoal now smell like cinnamon? For example, the mineral Sapphire hematite varies in color (red, brown, or black), but it always makes a reddish-brown streak. Equivalently, when the density of the balloon (including its load) equals the density of
the surrounding air, the balloon ceases rising. If you don't see your shadow, cancel your plans! Altocumulus clouds appear as gray, puffy masses in parallel waves or bands. (Plasma, recall, is the phase of matter beyond gas, consisting of ions and electrons rather than atoms—electrons have been stripped from atoms by high energies.) The nuclei of
this plasma move fast enough to undergo nuclear fusion, as discussed in Section 13.7. The energy released from this nuclear fusion rises to the surface, where it causes gases to emit a broad spectrum of electromagnetic radiation, centered in the visible region (see Figure 11.31). The greater the weight, the greater the mass. Let the dimes represent a
radioactive isotope, such as carbon-14, while the pennies represent a nonradioactive isotope, such as carbon-12. We can understand this by dividing the solar radiation curve into three regions, as in Figure 11.32. (a) (b) Faults that exhibit horizontal movement, in which blocks of rock slip past one another with very little vertical displacement, are
called strike-slip faults (Figure 21.35). The color of the mineral corundum, Al2O3, is commonly white or grayish. Ferromagnesian silicates contain iron (Fe) and magnesium (Mg); they tend to be dark and dense. For masses greater than a certain amount, called the critical mass, an explosion of enormous magnitude may take place. For hydrogen
peroxide, the O i O bond should be rotated so that the two hydrogen atoms are as far apart as possible. Photograph (a) shows the Moon partially lit by the Sun. In either case, pseudoscience is very big business. On the Moon partially lit by the Sun. In either case, pseudoscience is very big business. On the Moon partially lit by the Sun. In either case, pseudoscience is very big business.
divided between the two scales. We can measure how much time passes between the arrival of one crest and the arrival of one crest and the arrival of the next one (the period), and we can also observe the distance between the arrival of one crest and the arrival of one crest an
with any freely falling object. Which molecule from each pair should have a higher boiling point (atomic numbers: Cl = 17, O = 8, C = 6, H = 1)? It is as though gravity and dark energy are diametrically opposed. A vacuum cleaner wouldn't work on the Moon. Charged particles in this hyperspinning disk create a narrow yet ultrastrong magnetic field
that rises from the black hole's poles. Local Group Our immediate cluster of galaxies, including the Milky Way, Andromeda, and Triangulum spiral galaxies plus a few dozen smaller elliptical and irregular galaxies, including the Milky Way, Andromeda, and Triangulum spiral galaxies plus a few dozen smaller elliptical and irregular galaxies. 128. So while our region of the universe expands to infinity, other regions are just being born. In what sense can you truthfully say that a few dozen smaller elliptical and irregular galaxies.
you are a part of every person around you? Low-cost methods for removing arsenic from well water are greatly needed, as are worldwide recognition of this problem and the political, economic, and social support to overcome it. Notice that each of the successive equal time intervals noted on the horizontal scale corresponds to a doubling of the
quantity indicated on the vertical scale. The acceleration is zero for an object that moves a book 2 m in a time interval of 1 s? To attain the higher ethanol concentrations found in "hard" alcoholic beverages such as gin and vodka, the fermented
liquid must be distilled. Air pressure is greater at A, and the ball curves as shown. See further development of linear motion in Appendix A. If the object is at rest, it continues in a state of rest. The vibrating electrons, in turn, re-emit light in various directions. Both countries installed sensitive seismographic stations to monitor their opponent's
activities. So rock deep below the surface is prone to plastic flow, but rock at the surface is more apt to fracture and break. With so many minerals, how can they all be classified in a simple, systematic fashion? The answer is 1 m/s (it covered 1 meter in the interval of 1 second). Cite at least four types of information needed to predict the weather
Unfortunately, CFCs degrade slowly, and the ones that are there now will remain there for many years to come. (a) The velocity of the ball at the highest point of its vertical trajectory is instantaneously zero. If it comes in too shallow, it could bounce back into space like a pebble skipped across water. Does your answer contradict the law of energy
conservation? 89. The entire state of Nevada, eastern California, southern Oregon, southern Utah are greatly affected by normal faulting. High-frequency sound (ultrasound) that enters the body is reflected more strongly from the organs (Figure 10.15). Bohr's
planetary atomic model proved to be a tremendous success. This force is greatest when the charge moves perpendicular to the field lines and is smallest (zero) when it moves parallel to the field lines and is smallest (zero) when it moves parallel to the field lines. REVIEW 55 23. Despite its successes, though, Bohr's model was limited because it did not explain why energy levels in an atom are quantized. The
Coriolis force deflects winds toward the right in the Northern Hemisphere and toward the left in the Southern Hemisphere and the left in the Southern Hemisp
32, such as 16 or 8, would do. The great philosopher and mathematician Bertrand Russell (1872-1970) wrote about ideas in the liquid, will a piece of quartz sink or float in the liquid? The egg floats in salt water, evidence that salt
water is more dense than fresh water. (c) color. Stomach acid is so strong that within this environment aspirin cannot donate its hydrogen ion, which means that it remains "un-ionized aspirin is nonpolar and water insoluble. Which has more mass: a 2-kg fluffy pillow or a 3-kg small piece of iron? The amount of air an underwater diver
needs to breathe (c) Gas for many minutes, for example, can be squeezed (compressed) into a tank small enough to be carried on the diver's back. Some people fear drinking distilled water because they have heard it leaches minerals from the body. Photographs of atoms, such as in Figure 12.1, are obtained with a scanning probe microscope. Not
only can lithium maintain a higher 1 voltage than zinc, but it also is about 13 as dense, which allows for a lighter battery. CHECKPOINT Distinguish between a dipole-dipole attraction and a dipole-dipole attraction and a dipole-dipole attraction and a dipole-dipole attraction. A far better approach is to make the solution by first adding the sodium chloride (solute) to an empty container calibrated for 10
L and then adding water (solvent) as needed to make 10.0 L of solution. Oort cloud The region beyond the Kuiper belt populated by trillions of icy bodies and a source of long-period comets. Crystallization The growth of a solid from a liquid or gas whose atoms come together in specific chemical proportions and crystalline arrangements.
Polypropylene is a tough plastic material useful for pipes, hard-shell suitcases, and appliance parts. builds up a positive The reason the electric current is not sustained is shown in charge that attracts preventing Figure 18.22. .Ge. . For example, radium-226 has a half-life of 1620 years, which means that half of a radium-226 sample will be converted
to other elements by the end of 1620 years. Therefore the formula mass of pyroxene is 1 MgO + 1 FeO + 2 SiO2 = 232 amu and the mass percentages are 40 amu ^{2} * 100% = 52% SiO2 232 amu 60 amu ^{2} * 225 kg = 117 kg of silica. In response, several American
manufacturers have developed tabletop systems that bathe water with pathogenkilling ultraviolet light. Furthermore, the number of elements in each period is equal to the shell's capacity for electrons. If we touch the two electrons are to the number of elements in each period is equal to the shell's capacity for electrons. If we touch the two electrons are to the number of elements in each period is equal to the shell's capacity for electrons. If we touch the two electrons are to the number of elements in each period is equal to the shell's capacity for electrons.
\. What shape does your finger sweep out on the wall? Put yourself in the place of a water molecule (the one at the bottom). Collect all the salty water and evaporate away the water. FIGURE 6.21 Close to 0°C, liquid water
contains crystals of ice. (c) met our end. Eons (hidden life and visible life) and eras (ancient, middle, and recent life) mark very large time spans. Running water is the dominant agent of erosion. It is the closest planet to the Sun. Scientists estimate the age of our universe to be about (a) 5000 years old. Statement (b) has no test for possible wrongness.
and is therefore unscientific. Objects whose motions were unnatural were either pushed or pulled. Does the reading of the scale increase or remain the balloon while the negative part is repelled. 782 PA R T F O U R ASTRONOMY F I G U R E 2 8.1
7 As large as a galaxy is, its diffuse halo of dark matter is much larger. Why does magma composition change as it cools? Sediment shape and size give us clues to the method of sediment transport. A B FIGURE 10.29 Top view of water waves made by a stationary bug jiggling in still water. Cinder cone volcanoes are very steep but small in comparison
to shield volcanoes. Interesting, Newton's third law also plays a significant role in airplane flight—wing pushes air downward; air pushes wing upward. The irregular galaxy shown in Figure 27.30 is an example of a starburst galaxy. The complete cycle of solar activity is 22 years. What would be different in its operation if instead of carrying floating
boats it carried scrap metal that doesn't float? Two 100-N weights are attached to a spring scale as shown. Which should be larger: the potassium ion, K + , or the potassium atom, K? How does the number of protons in the atomic nucleus? Research is currently under way to
develop a synthetic dry glue based on gecko adhesion. Show that the scooter in the preceding problem will have four times the kinetic energy when its speed is doubled to 4 m/s. Upon mixing, the washing soda turns the solution basic, as evidenced by the pink color that forms. Much more difficult is it to think forward and project possible scenarios.
(b) An external force acts on the cue-ball system, and its momentum decreases. By analogy, consider yourself. A galvanometer and a motor are similar in that they both use coils positioned in a magnetic field. But if the pieces are suddenly driven together, the total surface area decreases. We usually cannot feel 12 V, and 24 V just barely tingles. In the
United States, the ethanol content of distilled alcoholic beverages is measured as proof, which is twice the percentage of ethanol. As it (a) vaporizes, it (b) creates pressure (inside arrows), which pushes ether up the tube. Another difference is the velocity dependence of the two. (b) copper. 27.2 The Brightness and Color of Stars 5. The exception was
that Einstein's theory predicted that the elliptical orbits of the planets should slip forward with each revolution, a process known as precession (Figure 28.14). In the next second, you go from 35 km/h to 40 km/h, and so on. But there is no evidence of glaciation in the Northern Hemisphere at that time. CHAPTER 16 1. the naturally occurring reddish-
brown substance you know as rust, shown in Figure 18.32: 4 Fe Iron + 3 O2 Oxygen + 3 H2 O Water h 2 Fe2O3 # 3 H2O Rust Another common metal oxidized by oxygen is aluminum. Do all the molecules in a liquid have about the same speed, or do they have a wide variety of speeds? Liquids generally expand more for an equal increase in
temperature. Does the sucrose disappear because it somehow ceases to occupy space or because it fits within the nooks and crannies of the water? Also, cans of diet soda float whereas cans of regular soda sink in water. Pour the warm sugar syrup into a jar. We consider many substances insoluble in water, including sand and glass. A scanning probe
microscope can also be used to push individual atoms into desired positions. This is called destructive interference. What happens to the current in the other lamps if one lamp in a series circuit burns out? Suppose two teams of nine horses each could pull them apart. What happens to the brightness of each lamp in a parallel circuit when more lamps
are added in parallel to the circuit? As we shall soon see, weight = mg (or mass * acceleration due to gravity), so 9.8 N = (1 kg)(9.8 m/s2). 467 Acid rain remains a serious problem in many regions of the world. As the radiation is absorbed by reactant molecules, the atoms in the molecules may start to vibrate so rapidly that the bonds between them
expansion of this growing technology. Do you agree or disagree, and why? (b) At its maximum altitude it starts to come back toward Earth. (c) Acetic acid, C2H4O2, is a weak acid; in water, only a small portion of its molecules break up into ions. Newton resigned his professorship and directed his efforts toward greatly improving the workings of the
mint, to the dismay of counterfeiters who flourished at that time. If the complexity of science intimidates you, bear this in mind: All the PE warms the ball: 0.5mgh = cm©T. The difference involves the different frontal areas while falling. The half-life of carbon-14 is
about 5730 years. Plants commonly leave their impression as a thin film of carbon. Every 10,000 years or so we are hit with a meteorite big enough to create a large crater, such as the one shown in Figure 26.40. In California alone, more than FIGURE 16.35 Carbonating your own water is not only fun, it's cheaper and more ecologically sound than
purchasing your soda from a store. In this section, we explore further how the physical properties of a material, such as boiling point, can be deduced from the polarity of its molecules. The Moon is going though its waxing crescent phase (waxing means "increasing"). To improve the odor and flavor of the water, many treatment facilities also aerate
the water by cascading it through a column of air, as shown in Figure 16.28. Because less weight is exerted on the outer core, the pressure is less and so the iron and nickel are liquid. Discuss and defend your answers. Gold has a density of 19.3 g/cm3. When you are traveling in your car at highway speed, the momentum of a bug is suddenly changed
as it splatters onto your windshield. Whatever the width of the same width. Tap water is a mixture containing mostly water but also many other compounds. For each crate, rank the following from greatest to least: (a) impulse delivered, (b) change
in momentum, (c) final speed, and (d) momentum in 3 s. 428 PA R T T W O CH E M I S T RY LEARNING OBJECTIVE Identify whether a chemical equation is balanced or not balanced or not balanced or not balanced. The frequency she receives is lower than the frequency you sent. You'll see this happen with the longitudinal lines on any globe. These are the clouds childhood
daydreams are made of. Accumulation The amount of snow added, and the process of adding snow, to a glacier. Within minutes, the supergiant's iron core, about the size of Earth, collapses into a ball of neutrons only several kilometers in diameter. * When you're flying at high altitudes where the outside air temperature is typically -35°C, you're quite
comfortable in the warm cabin—but not because of heaters. * Recall from Chapter 3 that power = work /time; 1 W = 1 J/s. Above 4°C, thermal expansion exceeds contraction and volume increases as temperature increases as temperature increases. C H A P T E R 10 CHECKPOINT When a light or sound source moves toward you, is there an increase or a decrease in the wave
speed? You'll appreciate these daily wonders of nature even more! F I G U R E 11. Any object that is electrons cannot be divided into fractions of electrons. Ketone An organic molecule containing a carbonyl group, the carbon of which is bonded to two carbon atoms.
To make a compass, point an ordinary iron nail along the direction of Earth's magnetic field (which, in the Northern Hemisphere, is angled downward as well as northward) and repeatedly strike it for a few seconds with a hammer or a rock. We see that the boiling point of 1-pentanol (the molecule at the bottom) is relatively high because 1-pentanol
molecules are so attracted to one another (by induced dipole-induced dipole-induc
They are called the terrestrial planets. Nonbonding pairs Two paired valence electrons that are not participating in a chemical bond. It doesn't change as the boulder sinks because the boulder sinks b
sustaining? As a final step, the water is treated with a disinfectant, usually chlorine gas, Cl2, but sometimes ozone, O3, and then stored in a holding tank that feeds into the city mains. Law A general hypothesis or statement about the relationship of natural quantities that has been tested over and over again and has not been contradicted; also known
as a principle. The principal difference is that the current in a motor is made to change direction each time the coil makes a half rotation. The historic leap came in the following year with a nonmetallic compound that lost its resistance at 90 K. Bernoulli's principle refers only to the internal pressure changes in a fluid. Radiants refer to constellations.
How would Aristotle explain this behavior? The key concept is that the Moon takes the same amount of time to complete one rotation as it does to revolve around Earth. As she drew closer and closer to the black hole, however, she would need to shine the light beams closer and closer to the vertical for escape. R O CK S A N D M I N E R A L S 541 (a)
Well-sorted sediments (b) Poorly sorted sediments FIGURE 20.26 A deposit that contains particles of similar shapes and sizes is called well sorted. Black ink contains pigments of many different colors. Correct your friend's ignorance. Twice the distance is 1/4 the intensity and 1/4 the reading. So the droplets are "floated up" by the upward-rising air
The double brick in Figure 2.9 for example, has twice the gravitational attraction of the single brick. (The induction of an electric field.) R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 1. When Earth first formed, its elements were distributed evenly.
The disturbance, not the air itself, travels across the room at this speed. The ground shakes 10 times more. Will reacting 5 g of carbon with 8 g of oxygen also result in 11 g of carbon dioxide? of water molecules passing in both directions across the membrane are the same Because more water molecules exist and the system reaches equilibrium, as
shown in Figure 16.33b. The kinetic energy of an object depends on the mass of the object as well as its speed. A ladybug twice as far from the center moves twice as far from the interaction—one thing (object A) interacts with another (object B). The
natural state of the perfume molecules is to spread out, to reach a state of increased disorder and increased diso
protons, a neutron becomes radioactive and spontaneously transforms to a proton and an electron. A stretched or compressed spring, for example, has the potential for doing work. A reducing agent causes other materials to gain electrons because of its tendency to lose electrons. Crystallization starts when atoms begin to bond with each other in a
particular geometric pattern. Law of mass conservation Matter is neither created nor destroyed during a chemical reaction; atoms merely rearrange, without any apparent loss or gain of mass, to form new molecules. Mars has two small moons—Phobos, the inner one, and Deimos, the outer. The difference, though, is that solubility rather than melting
point determines which minerals crystallize first. The largest moon, Triton, orbits Neptune in 5.9 days in a direction opposite to the planet's eastward spin. d Choose the BEST answer to each of the following. This results in a greater intensity of scattered light than there would be if the same number of electrons were vibrating separately. Soon
thereafter, Meitner, force. The color shows minor temperature variation on the order of 0.0001 K. 9.1 Magnetic Poles 2. Ohm's law can be stated V = IR. Then, double hint: Which wins, the fast ball or the slow ball?) A-4 APPENDIX A CHECKPOINT 1. If drawn correctly to scale, Andromeda is only about 20 Milky Way diameters away from the Milky
Way. Thus, the bug encounters a wave barrier. Experiment, not philosophical discussion, decides what is correct in science. * This can be derived as follows: If we multiply both sides of F = ma (Newton's second law) by d, we get Fd = mad. How does the impulse resulting from the impact differ if her hand bounces back upon striking the bricks?
Invoking ideas from Chapter 2 and this chapter, discuss why is it easier to throw a curve with a tennis ball than a baseball. Do they show that air exerts pressure or that there is a "force of suction"? (c) either away from or toward the normal. Hold your hands outstretched in front of you, one twice as far from your eyes as the other, and make a casual
judgment as to which hand looks bigger. Hardy, Futures: 50 Years In Space/ Photo Researchers, Inc. 21 ar. Because green is the only color at all and appears black. How this will play out is not known. These molecules leave the ground, mix with the air, and then
enter the dog's nose and activate its sense of smell. The answers to these ET questions appear only in the Instructor Manual. For their dedication to this edition, we praise the staff at Pearson in San Francisco. How is a mineral different from a rock? Cool air F I G U R E 1 0 .1 2 The plastic plates above the orchestra reflect both light and sound. This
transmutation can be written as a nuclear equation: 92 146 90 144 238 92 U 234 90 Th 2+ 20 4 2 He We see that 238 92 U transmutes to the two elements written as a nuclear equation: 92 146 90 144 238 92 U 234 90 Th 2+ 20 4 2 He We see that 238 92 U transmutes to the two elements written as a nuclear equation.
thing we can really 11. (d) Newton's second law. The field doesn't extend much more than one millimeter, and it wouldn't penetrate the skin, let alone into muscles. (c) either an elastic or an inelastic collision. The observer would measure a higher frequency. (The specific heat capacity of water is 1.0 cal/g # °C.) (a) Assuming 40% efficiency, show that
the peanut's food value is 3500 cal. 378 PARTTWOCHEMISTRY FIGURE The two unpaired valence electrons of two hydrogen atoms to form the covalent compound water. Or via formula, the refrigerant would draw away Q = mLv = (4000 g)
(200 cal/g) = 800,000 cal. No conduction, as in a cardboard tube, means no induced field and no slowness of fall. In Earth's interior, does temperature increase or decrease with depth? PARTHREEE arth Science You're right, Emily, it is the perfect place. (e) mass. When direction doesn't change, acceleration may be expressed as the rate at
which speed changes. Many dry cereals are fortified with iron, which is added to the cereal in the form of small amounts of chromium in place of aluminum produces the red gemstone ruby. Such a break occurs when the switch is opened, when
wire is accidentally cut, or when one of the lamp filaments burns out. The car has no tendency to resume its original twice-as-fast speed. 6.3 Heat EXPLAIN THIS Why do we say that no substances contain heat? So we see that reverse osmosis is a mechanism for generating fresh water from salt water. 564: Princeton University, Geosciences
Department 565: iStockphoto.com 566: USGS 572: (top) Dinodia Photos / Alamy 572: (bottom) U.S. Geological Survey, Denver 573: Bernhard Edmaier/AGE Fotostock 575: B. Distinguish between foliated and nonfoliated metamorphic rocks. Fortunately, smaller meteorites hit us more frequently than larger ones do. Christian Oersted discovered, in a
classroom demonstration, that an electric current affects a magnetic compass. Draw in the two components. See also Big Bang; Space/time structure Coulomb, 190 Coulomb's law, 189-191 Covalent bonds, 376-382 polar, 379-382 Covalent compounds, 377 Cretaceous extinction, 636-637 Critical mass, 335 Cross-cutting relationships, 621 Crust of
Earth, 522-523, 560-561 folds in, 574-575 Crystallization, 530-533 in magma, 530-531, 549 in water solutions, 532-533 Cumulus clouds, 692 Current, electric. Jumping ability is best measured by a standing vertical jump. From what naturally occurring compound is aspirin prepared? Is a radio wave also a sound wave? Defend
your answer, and explain why the two fall differently. Why does a struck tuning fork sound louder when its handle is held against a table? If a magma contains molten forms of mineral B (25% silica), which would crystallize last as the magma contains molten forms of mineral B (25% silica), which would crystallize last as the magma contains molten forms of mineral B (25% silica) and mineral B (25% silica).
should be used very sparingly or not at all. According to Galileo, inertia is a (a) force like any other force. The rocks were similar in both age and type. Show that 480 W of power is expended by a weightlifter when lifting a 60-kg barbell a vertical distance of 1.2 m in a time interval of 1.5 s. For example, water fully aerated at room temperature
contains only about 1 oxygen molecule for every 200,000 water molecules. 5 6 PROLOGUE T H E N AT U R E O F S CI E N CE LEARNING OBJECTIVE Distinguish between natural and supernatural phenomena. Accident investigators are well aware that an automobile going 100 km/h has four times the kinetic energy it would have at 50 km/h.
Occupants inside future donut-shaped rotating habitats in space will be pressed to their floors by rotational effects. When iron oxide acts as a cementing agent, it produces the red or orange stain often seen in sedimentary rocks. The atomic mass of bromine is reported in the periodic table as 79.904 amu. According to the second law of
thermodynamics, exothermic reactions, such as the burning of wood, are favored because they result in the dispersal of energy. As a result, there are only a few hydronium or hydroxide ions.) You shouldn't be too alarmed, therefore, when you discover that some toothpastes are formulated with small amounts of sodium hydroxide, one of the stronges
bases known. 5 5 (a) (b) A rope analogy illustrates the effect of crossed Polaroids. The three kinds of convergent plate boundaries are: 1. The result is a flock flying in a V formation. Microscopic herapathite crystals are aligned and embedded between cellulose sheets. Discuss. C H A P T E R 11 11.1 Electromagnetic Spectrum EXPLAIN THIS LIGHT
265 LEARNING OBJECTIVE Describe the nature and range of electromagnetic waves. When Anette Zetterberg heats the ball, it does not pass through the ring. Because the book is in equilibrium, there must be another force acting on it to produce a net force of zero—an upward force opposite to the force of gravity. 9.10 Field Induction EXPLAIN
THIS LEARNING OBJECTIVE Describe how the nature of light relates to electromagnetic induction. What do these measurements tell us about the Sun's motion? The greater an object's distance from Earth's Apple weighs weighs weighs weighs the same and the sun's motion? The greater and object weighs and the sun's motion? The greater and object weighs weighs weighs weighs and the sun's motion? The greater and object weighs and the sun's motion? The greater and object weighs weighs weighs weighs and the sun's motion? The greater and object weighs weighs weighs weighs and the sun's motion? The greater and object weighs weighs weighs weighs weighs and the sun's motion? The greater and object weighs weighs weighs and the sun's motion? The greater and object weighs weighs weighs and the sun's motion? The greater and object weighs weighs and the sun's motion? The greater and object weighs weigh and the sun's motion? The greater and object weighs weight and the sun's motion weighs weight and the sun's motion.
inversion, caused by cold air from the ocean being capped by a layer of hot air moving westward over the mountains from the hot Mojave Desert. In a movie, the hero jumps straight down from a bridge onto a small boat that continues to move with no change in velocity. Our idealized treatment serves as an analogy for the production of the less
complex shock waves in air. As air temperature decreases, relative humidity (a) increases. The average speed of molecules in both containers is the same. Under ordinary conditions, there are as many conduction electrons swarming through the atomic lattice as there are positively charged atomic nuclei. In Earth's interior, seismic waves are
reflected by the "surfaces" between differing materials. Make the lowest-pitched vocal sound you are capable of; then keep doubling the pitch to see how many octaves your voice can span. Why do you want to add only a small pinch of washing soda and not a tablespoon? Within a clump, ordinary and dark matter may initially have been uniformly
mixed together. Another factor that affects air pressure is density. TUTORIAL: Newton's Third Law When pushing my fingers together I see the same discoloration on each of them. Water vapor condenses onto the nearest available surface. Why does the boiling temperature of water decrease when the water is under reduced pressure, such as at a
higher altitude? What do radio waves and light have in common? Heat can be made to flow the other way only when work is done on the system or by adding energy from another source. At one time brewed for its antipyretic (feverreducing) effect, salicylic acid is an important analgesic (painkiller), but it causes nausea and stomach upset because of
its relatively high acidity, a result of the presence of two acidic functional groups. What does the proportion of lead and uranium in rock tell us about the age of the rock? The corrosiveness of these materials is a result of their strength. r a 2016 M 201 2N ov. The opposing forces consist mainly of water resistance against the hull of the boat. Canned
food requires subzero temperatures to freeze because of its salt or sugar content. Clouds can act like a blanket around Earth's surface. The one who climbs in 30 s uses more power because the work is done in a shorter time. Then
switch places with a friend so you can hear it too. As the day progresses and the Sun descends lower in the sky, * This type of scattering, occurs whenever the scattering particles are much smaller than the wavelength of incident light and have resonances at frequencies higher than those of the scattered light. evaporated
into its atmosphere. Winds are caused by the unequal heating of the surface and therefore the atmosphere. The diet drink is less dense than water, whereas the regular drink is denser than water and protons is
electrically charged. Valence shell The outermost occupied shell of an atom. Suppose you wish to connect a pair of resistors in a way that their equivalent resistance is less than the resistance of either one. This technique was useful with clothes irons before the advent of thermostats. Electron beam Force F I G U R E 9 .1 6 A beam of electrons is
deflected by a magnetic field. Since its discovery in 1930, however, astronomers knew that Pluto was quite different from all the other known planets. The larger a sediment particle, the stronger a current must be to carry it. A second reason that not all collisions lead to product formation is that the probability that N2 and O2 molecules will collide
and form nitrogen reactant molecules must also collide with enough kinetic energy to break their bonds. 1.6 Support Force EXPLAIN THIS How does support force relate to your weight? Batteries So we can see that, with the proper setup, it is possible to harness electric energy from an oxidation-reduction reaction. We also hear about Swirling
storms and disturbances caused by solar activity produce "space weather" between the Sun and Earth. Complexities arise when assessing the polarity of a molecule containing more than two atoms. We don't notice that air has weight because we're submerged in air. What finally becomes of all the uranium that undergoes radioactive decay? The coils
repel large magnets on the train's undercarriage. Technology is a double-edged sword. (c) What would be the landing speed of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in a headwind of 60 km/h? Sunspots are typically twice the size of Earth, move around because of the plane in the size of Earth, move around because of of Earth, move 
observer outside the spaceship still sees a straight-line path, but to an observer in the accelerating spaceship the path is curved; it is a parabola. Notice that eventually you get down to the last coin, which may or may not decay on the next throw. This effect occurs because with an increase in temperature, the solvent molecules have more kinetic
19.33 Terephthalic acid and ethylene glycol polymerize to form the condensation copolymer polyethylene terephthalate. But why is Earth round? Why is schist so easily recognized? During distillation, one of the components of the mixture is boiled and the vapor is collected in another container. If the yellow clothes are illuminated with a
complementary blue light, they will appear black. (b) almost directly behind Earth, so that Earth is between the Sun and the Moon. The higherfrequency sine waves are the partials, which give the characteristic quality. Suppose an oxygen atom gains two electrons to become an oxygen ion. Now we say that light can be bent by gravity. It should come
as no surprise that the amount of carbon dioxide put into the atmosphere by human activities is growing. Energy output soars, moving the star off the main sequence. The grayish haze in the skies over large cities is the result of particles emitted by automobile and truck engines and by factories. We know that a falling object accelerates toward Earth
because of the gravitational force of attraction between the object and Earth. This work, for example, can heat a circuit or turn a motor. Absolute zero is 0 K (short for "0 kelvins"; note that the word degrees is not used with Kelvin temperatures).** There are no negative numbers on the Kelvin scale. If air resistance isn't a factor, then the acceleration
of the tossed stone everywhere is g while in flight—even at the top—and tossed at any angle. Critical mass The minimum mass of fissionable material needed for a sustainable chain reaction. The phenol 4-hexylresorcinol, for example, is commonly used in throat lozenges and mouthwashes. The first step is to balance the atoms by showing two iodide
ions, I-: Fe3+ + 2 I-S Fe2+ + I2 The charges can then be balanced by showing two Fe2+ ions: 2 Fe3+ + 2 I-S 2 Fe2+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + 2 I-S 2 Fe2+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + 2 I-S 2 Fe2+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + 2 I-S 2 Fe3+ + 2 I-S 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + 2 I-S 2 Fe3+ + 2 I-S 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + 2 I-S 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can then be balanced by showing two Fe3+ ions: 2 Fe3+ + I2 The charges can the charges c
faces the right hand of her image. As warm, moist air rises, it cools and becomes less able to accommodate water vapor. You don't say that voltage flows through a circuit. The valence electron of a sodium atom does not sense the full 11+ of the sodium nucleus. In the beginning of the 20th century, many were opposed to the introduction of electricity
because of its inherent dangers. Electric motors have greatly changed the way people live. What is the concentration of hydroxide ions? The heat of friction causes the red phosphorus to convert into white phosphorus—an alternate form of phosphorus to convert into white phosphorus.
in one direction throughout the crystalline copper atoms, which are actually positive ions, are forced in the opposite direction. Does the medium in which a wave travels move with the wave? 298 PA R T T W O CH E M I S T RY an oxygen atom has a total of eight protons and eight electrons and is thus electrically neutral. The fact
that the water level remains constant indicates equal rates of evaporation and condensation. If the forces that act on a cannonball and the recoiling cannon from which it is fired are equal in magnitude, why do the cannonball and the recoiling cannon from which it is fired are equal in magnitude, why do the cannonball and the recoiling cannon from which it is fired are equal in magnitude, why do the cannonball and cannon have very different accelerations? Often a larger, secondary bow with its colors reversed can be seen arching at a
greater angle around the primary bow. Your mass is the same in both locations or in any location. Because no light is reflected, the ink appears black. c, 6. Unless the light is perpendicular to the surface of penetration, bending occurs. Note from Table C.3 that when eight grains are placed on the fourth square, the eight is one more than the 3 4 7
total of seven grains that were already on the board. 4.1 The Universal Law of Gravity 2. Wild plants readily grow "all by themselves," yet the molecules of the growing plant have less entropy than the materials used to make the plant. So the 16 g of methane reacts with oxygen to produce 44 g of carbon dioxide plus 36 g of water. There are also two
types of surface waves: Rayleigh waves and Love waves. Plates carrying continents, such as the Pacific Plate, tend to move much faster. As the number of parallel branches is increased, the overall resistance of the circuit is decreased. The water obtained from these deep
wells, however, is highly contaminated with arsenic—a naturally occurring element in Earth's crust. So, muscovite cleaves where its bonding is weak—between its planar sheets. In fact, grime guickly finds itself surrounded in three dimensions by the nonpolar tails of soap molecules. After firing, the net momentum is still zero, because the momentum
of the cannon is equal and opposite to the momentum of the cannonball. (Note that the convention is to write the numeral before the sign, not after it: 2+, not + 2.) We can use the shell model to deduce the type of ion an atom tends to form. Instead, the energy spreads away from the pan and into the cooler surroundings. If you place a candle in fronts
of a mirror, rays of light radiMirror ate from the flame in all directions. Sodium fluoride LEARNING OBJECTIVE Show how the shape of a molecule affects the 
Were these your answers? The first was that if you could run the movie backward, you would find a time when the whole universe was compressed to a very small point. The 11.3 kg of the lead is irrelevant; 1 L of anything submerged in water displaces 1 L and is buoyed upward with a force 9.8 N, the weight of 1 kg. Yes, and this occurs as two
symmetrically shaped galaxies collide to form an asymmetrically shaped irregular galaxy. The methods of mathematics and experimentation led to enormous success in science.* Scientific method advances LEARNING OBJECTIVE List the steps in one scientific method, and cite other
methods that advance science. The curved path in the third view is best analyzed by considering the horizontal and vertical components of motion separately. TA B L E 2 0. Bleier/Photolibrary/ Peter Arnold, Inc. The images clearly distinguish between fluid and bone, for example. But all that was about to change. We say relatively cool because they
 are hotter than 4000 K. Kinetic energy g 1 2 2 mv 45. E X E R C I S E S (SYNTHESIS) 37. Objects moving at constant velocity move the same direction. What color is this star—and why? To the cannoneers of earlier centuries, the curved paths of projectiles seemed very complex. (a) Graphite conducts electricity
Bob Greenler displays a colorful giant bubble on page 264, Ron Hipschman freezes water on page 206, Chelcie Liu shows his novel display on page 204, John Hubisz demonstrates entropy on page 204, Ron Hipschman freezes water on page 204, In Hubisz demonstrates entropy on page 206, In Hubisz demonstrates entropy on page 207, In Hubisz demonstrates entropy on page 208, In Hub
race tracks in Figure A.3 in Appendix A, Jennie McKelvie makes waves on page 249, Fred Myers shows magnetic force on page 219, Sheron Snyder generates light on page 255. The capacity for nuclear radiation to cause damage is
not just a function of its level of energy, however. If we increase the pressure, the temperature needs to be higher for boiling to occur. The same types of minerals always have the same geometric arrangement of atoms. As an analogy, consider a group of people on a dance floor—as the number of people increases, so does the rate at which they bump
into one another. THINKANDRANK (ANALYSIS) 56. After so many seconds t, it should be at a certain point along a straight-line path. That's because they are even smaller than the wavelengths of visible light. Which of these is a true statement about silicate minerals? PLUGANDCHUG(FORMULAFAMILIARIZATION)
Quantity of heat: Q q cm©T Heat of vaporization: Q q mLv 40. A billiard ball and a bowling ball have the same speed. (c) of the tilt of Earth's polar axis. CHAPTER 5 5.2 Pressure EXPLAIN THIS Why does wearing high heels increase the pressure on the floor? In order for these bonds to be broken, collisions between the molecules must contain enough
energy to break the bonds. may collide with no reaction. We understand that muscles require exercise in order to stay in shape. Inelastic collision. This forces the iron to accept electrons, which means that it is behaving as a cathode. 784 PA R T F O U R ASTRONOMY FIGURE 28.20 The expansion of space started to accelerate about 7.5 billion years
ago, which is shown on this diagram as a gradual widening just after the development of galaxies. Likewise with rainbows. Consider these atoms: helium, He; chlorine, Cl; and argon, Ar. Rank them in terms of their atomic number, from smallest to largest. We can understand this by comparing a satellite in circular orbit with a bowling ball rolling
along a bowling lane. A cup of hot water and a cup of cold water, for example, won't blend to make a cup of warm water unless they are able to mix. (right) Roll it along a level surface, and its velocity is constant because no component of gravitational force acts horizontally. Granitic magma, at about 70% silica, cooling slowly at depth forms granite
and other similar granitic rocks. The ionic and covalent bonds discussed in this chapter all result from either a transfer or a sharing of unpaired valence electrons. Only when the craft moves faster than sound do the waves overlap to reach the listener in a single burst. We know that electric charges of like sign repel one another. FIGURE 26.22 Three
steps to the formation of Earth's Moon. CHAPTER 3 MOMENTUM AN D ENERGY 69 F I G U R E 3 .1 2 INTERACTIVE FIGURE Elastic collisions of equally massive balls. The Sun, in fact, has too little mass to experience such a collapse, but when some stars with core masses over 40 times greater than the mass of the Sun reach the end of their
nuclear resources, they undergo collapse; their collapse continues until the stars reach infinite densities. Refer to "Figuring Physical Science: Silica Enrichment in Magma" on page 531 to answer the following problem. 1 Astronomical Body Sun Sun (at a distance of Earth's orbit) Jupiter Saturn Neptune Uranus Earth Venus Mars Mercury Moon You
won't fully appreciate FYI the frontiers of physical science unless you're familiar with its foothills. This component force is offset by the deep keel. a, 3. In other words, this is what we may look like from afar. Also, so much oxygen can dissolve in supercritical water that flames can burn within this medium, which is ideal for the destruction of toxic
wastes. Piston F I G U R E 1 3 .1 8 A cloud chamber. When water of weight w is added, the supplies goes down. Decrease? These water solutions usually contain many dissolved mineral constituents. Is the fact that we see only one side of the
Moon evidence that the Moon spins or that it doesn't spin? The explanation for this is shown in Figure B.12. b, a, d, c. The high summer and low winter temperatures common in Manitoba and the Dakotas, for example, are largely due to the absence of large bodies of water. Furthermore, unlike water, the atmosphere becomes less dense with altitude
20.2 Minerals EXPLAIN THIS The dominance of oxygen in Earth's crust becomes even more apparent when you consider its abundance, not by mass, but in terms of numbers of atoms: 63 out of every 100 atoms making up Earth's crust are oxygen atoms. 37 2 C H A P T E R 2 Newton's Laws of Motion G alileo's work set the stage 2. From the periodic
table we see that an oxygen atom has a mass of about 16 amu. At present rates of consumption, all natural sources of U-235 may be depleted within a century. A break in any one path does not interrupt the flow of charge in the other paths. Answers to the lab manual questions are in the Instructor Manual. FYI FIGURE 3.36 d. 700 PART THREEE
ARTHSCIENCEFIGURE25.19 Like a gigantic vacuum cleaner, the strong wind of a tornado can pick up and obliterate everything in its path. With axes at right angles, no light will be transmitted. 127. Occluded front B
CHAP TER 25 like a stalemate between fronts and, as such, can remain over an area for several days. Why does the melting point of hydrocarbons increases? Or, in shorter notation, Here's inversely proportional. What is the acceleration of a stone at the top of its trajectory when it has been tossed
straight upward? If life were to be found anywhere in this solar system besides Earth, it would likely be on the floor of Europa's ocean adjacent to volcanic thermal vents. How can adding plain water change the pH of a solution? What happens to the water vapor in saturated air as the air cools? If strontium-90 (atomic number 38) emits betas, it should
become the element yttrium (atomic number 39); hence the physicist can test a sample of strontium for traces of yttrium by spectrographic means or other techniques. Its average speed, however, is 1 m/s. (b) planetary atmospheres. Timing is especially important when changing momentum. REVIEW 35 82. Selective Reflection A rose, for example,
doesn't emit light; it reflects light. You exhale the carbon dioxide and water vapor, but much of the energy from the reaction is used to keep your body warm and to drive the many other biochemical reactions necessary for life. Roddy/ U.S. Geological Survey, Denver 730: (top) Dr. R. Then place the mirrors 60° apart so that you can see your face. It
still weighs 1 ton. In America, the Appalachian Mountains were produced from a continental-continental collision that ultimately resulted in the formation of the supercontinent Pangaea. A familiar example of a ketone is acetone, which is often used in fingernail-polish remover and is shown in Figure 19.20a. Loose atoms then form new bonds with
different atoms, which results in the formation of new molecules. Two identical longitudinal waves that are out of phase destroy each other when they are superimposed. The elevation of the equilibrium level depends on the environmental lapse rate. The mass of ice formed is (800,000 cal)/(80 cal/g) = 10,000 g, or 10 kg. The compass needle on the
left in Figure 26.28 rotates because of a pair of torques. Show that the water pressure at the bottom of the 50-m-high water tower in Figure 5.3 is 490,000 N/m2, or is approximately 500 kPa. CHAPTER 5 49. Hardened balls of grease from discarded cooking fats are also found. 1.9 Speed and Velocity 22. No work is done in moving it horizontally
(neglecting friction). FYI Earthquakes cause the ground to shake and rupture. Pennies manufactured after 1982 are made of zinc metal, Zn, in a coat of copper metal, Cu. Zinc is more easily oxidized than copper. Resonating atoms in the glass can hold on to the energy of the ultraviolet light for quite a long time (about 100 millionths of a second). As
any spinning object contracts, the speed of its spin increases such that angular momentum is conserved. Unless the completely submerged container is compressed, the buoyant force equals the weight of 1 kg at any depth. We'll see later that this right-angled force holds the shuttle in a circular path. Most of the basaltic magma erupts, but some
undergoes crystallization. Where the atmosphere contains a lot of particles of dust and other particles larger than oxygen and nitrogen molecules, light of the lower frequencies also undergoes significant scattering. Some spirals, such as the Sombrero galaxy of Figure 27.26, have a spheroid central hub. A shell is a region of space around the atomic
nucleus within which electrons may reside. Three types of cone-shaped receptors in our eyes perceive color. To scientists, it means uncertainty over the strength of a signal. Instead, they wallow in the mud to cool themselves. The canvas roof of a convertible car bulges upward when the car is traveling at high speeds. Hewitt Boston Columbus
Indianapolis New York San Francisco Upper Saddle River Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montréal Toronto Delhi Mexico City São Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo Publisher: James M. A nova is an event, not a stellar object. The boiling points of water and methane are less a consequence of the
masses of their molecules and more a consequence of the attractions among their molecules. The net result of the chemical reaction is a combination of atoms into more tightly bound molecules. Charging this battery causes the nickel metal to extract hydrogen from water to form the negatively charged hydride ion, shown below as H: where the two
dots represent two electrons.* H2 O + Water Ni + 2e- Nickel metal h HO- + H: Ni Nickel hydrogen, which, because it contains an added electron, is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron, is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which, because it contains an added electron is called the hydrogen, which is called the hydrogen is called t
Welcome. NH2 O O C C H HO OH Lysine NH2 C H A P T E R 19 63. Suppose that you're in a moving car and the ends of the chapters in this book. It explains why the Moon is so large (we started out as twin planets), why its composition is similar to Earth's
(it formed from our mantle and our mantle and our mantle formed from it), why it has such a small iron core (Earth's iron core had already differentiated and was A Mercury-sized planetesimal crashes into the young Earth, shattering both the planetesimal and our planet. Because of its insolubility, aluminum oxide forms a protective coat that shields the metal from
further oxidation. Wave interference is easiest to observe in water. Air that contains the maximum amount of water vapor for the temperature of the air mass is considered to (a) have a relative humidity of 100%. Which is thought to be more prevalent in the universe: dark matter or dark energy? Is it possible for a hydrogen nucleus to emit an alpha
particle? 2 5 A mirage. Which electrons are represented by an electron-dot structure? (b) How would air resistance affect the travel time? So, not surprisingly, the majority of earthquakes occur in just a few narrow zones (Figure 21.37). What remains is the harmony we observe. Sometimes molecular models or, simply, names may be used instead.
FIGURE 3.23 The downhill "fall" of the roller coaster results in its roaring speed in the dip, and this kinetic energy sends it up the steep track to the next summit. Not at all, for significant evaporation and condensation occur continuously at the molecular level. The relative humidity of an air parcel is 50%, and the pressure is 1000 millibars (mb). The
curved solid line shows the resulting trajectory that combines horizontal and vertical motion. About how many times would you have to do this to count all the atoms in a single grain of sand? The taller tree would need a height equal to the radius of Earth (6370 km) for the apple's weight at its top to reduce to 14 N. Leroy, who has a mass of 100 kg, is
skateboarding at 9.0 m/s when he smacks into a brick wall and comes to a dead stop in 0.2 s. The inner planets—Mercury, THE SOL AR SYSTEM 709 LEARNING OBJECTIVE Describe how nebular theory accounts for the main attributes of motion
relative nature of, 26-27 speed and, 24-27 INDEX support force and, 22 velocity and, 26-27 wave, 240-241 Motors, electric, 224 Musical sounds, 255-257 Fourier analysis and, 257 N Nanotechnology, 359-361 Natural frequency, 247 Neap tides, 658 Nebular theory, 711-712 Nebulas, 745-746 planetary, 747-748 Neptune, 710, 721 orbit of, 96 Net
force, 19 Neutral solutions, 462-465 pH of, 465-466 Neutralization reactions, 458-459 Neutron(s), 298-299 mass of, 338-339, 341 strong nuclear force and, 326-328 Neutron stars, 750 New Moon, 723 Newton's law of cooling, 171-172 Newtonian synthesis, 90 Newton's law of cooling, 171-172 Newton's law of universal gravitation, 91-93 Newton's laws of motion, 38-60
first law (inertia), 39-40, 52 second law (acceleration), 41-46, 52 third law (acceleration), 47-52 Nickel metal hydride batteries, 475 Nonbonding pairs, 368 Nonconformities, in rock record, 624 Nonfoliated metamorphic rocks, 548 Nonpolar bonds, 380 Nonsilicates, 528-529 Novae, 748-750 Nuclear energy, 81 Nuclear fission, 333-338 chain
reactions in, 334-335 critical mass in, 335 Nuclear fission reactors, 336-338 Nuclear fusion, 340-343 control of, 342-343 Nuclear fusion, 340-343 Nuclear fusion, 340-
red cabbage extract. And just as the bow wave of a speedboat spreads until it reaches FIGURE 10.33 Condensation of water vapor by rapid expansion of air can be seen in the rarefied region behind the wall of compressed air. Over regions closer to the equator, like Mexico, the incoming cosmic rays move more nearly at right angles to Earth's
magnetic field, and many of them are deflected back out into space before they reach the atmosphere. By convention, these hues are grouped into seven colors: red, orange, yellow, green, blue, indigo, and violet. We now understand that the acceleration of free fall is independent of an object's mass. If two of the three colors overlap, or are added,
then another color sensation is produced (Figure 11.33). However, in a facility located in a region surrounded by very deep ocean water, as is the facility shown in Figure 16.36, treatment requirements are less stringent. The sound that is produced sets up similar vibrations in the microphone. This occurs at a distance called the event horizon.
Suppose you apply the same amount of force to two separate carts, one cart with a mass of 1 kg and the other with a mass of 2 kg. 8 Buoyanc y in a Gas 5. Like a very slow magnetic tape recording, the Earth's magnetic history is recorded in the spreading ocean floors. The impacting object must have hit the young Earth not dead-on but askew, which
gave the Earth a fast rotation. Oppositely charged sides of the molecules in the surface of the door face the balloon and attraction results. Transform boundaries have mechanically deformed rocks. We see the bird and its reflection. Your friend then asks if this means that the skydiver is slowing down. Flex your wrist, elbow, and shoulder joints, and
you'll find your arm passing through a range of conformations. 3.6 Conservation of Energy 21. Just because a solid dissolves in a liquid doesn't mean the solid no longer occupies space. Dark energy makes up some 73% of the universe; dark matter makes up about 23%. Assuming today's laws of quantum mechanics held true at the time of FIGURE
28.6 For their efforts in developing the theory of cosmic inflation, Alan Guth (left) and Andrei Linde (right) in 2004 together shared the prestigious Cosmology Prize of the Peter Gruber Foundation. San Franciscans certainly are! CHECKPOINT Bermuda is close to North Carolina, but, unlike North Carolina, it has a tropical climate year-round. F I G U
R E 6 .1 4 Thermal expansion. How is average speed defined? The solubility of a gas in a liquid also depends on the pressure of the gas immediately above the liquid. 4 Electric Currents and Magnetic Fields 9. In these regions, the effect of acid rain on lakes and rivers accumulates. The flowing molten outer core produces a flowing electric charge—an
electric current. Two separate but similar coils of wire are mounted close to each other, as shown. The continental margins (shelf, slope, and rise), deep ocean basins (abyssal plains and hills), midocean ridges, and deep trenches. For a wave explanation of refraction (and diffraction), read about Huygens' principle, pages 512-515, Conceptual Physics
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-11th Edition. The atom then has one more positive charge (proton) than negative charge (electron) and is positively charged. (b) The water contains water molecule is pure. Would you expect to find dc or ac in the filament of a lightbulb in your home? Hot rock in Earth's interior rising beneath continental landmasses
generates tension in Earth's crust, causing it to stretch and bend upward (upwarping). Although 2-propanol has a relatively high boiling point, it evaporates readily, leading to a pronounced cooling effect when it is applied to skin—an effect once used to reduce fevers. A lot of damage for 15 seconds of shaking! Earthquakes are generally associated
with areas where lithospheric plates meet. In a fabric having only a little bit of red in it, the red is more apparent under an incandescent lamp than it is under a fluorescent lamp. When ice melts, not all the open-structured crystals collapse. There are no forces acting horizontally (neglecting air resistance), so there is no horizontal acceleration; hence
the horizontal component of velocity doesn't change. At this writing, fusion by magnetic confinement has been only partially successful—a sustained and controlled reaction has so far been out of reach. So the chemical formula NH3
tells us that the compound ammonia has one nitrogen atom for every three hydrogen atoms, as Figure 14.15 shows. Which is easier to get moving: a car battery or a king-size pillow? These fluids lower the melting point of the mantle rock, causing it to partially melt and generate basaltic magma. Tensional stress occurs when slabs of rock are pulled
apart. Lateral continuity Sedimentary layers are deposited in all directions over large areas until some sort of obstruction, or barrier, limits their deposition. The pressure is doubled when the balloon is squeezed to half its volume. You can't miss. The strong man will push apart the two initially stationary freight cars of equal mass before he himself
drops straight to the ground. Evaporites, such as halite, are formed by chemical precipitation caused by the evaporation of salty waters. It is, however, able to penetrate through the largely nonpolar HCl - containing mucous membrane that lines the stomach. (b) Show that the plane travels along the runway a distance of 450 m before takeoff. An
increase in light frequency is called a blueshift, because the increase is toward a higher frequency, or toward the blue end of the color spectrum. Fluorine therefore tends to form the 1 - ion. Surely, it seems to most of the bacteria that their problem is solved—and just in time. The plane of polarization matches the vibrational direction of the electron
If a substance has all the physical properties listed under gold, for example, it must be gold. It is common to think of distant rockets and the like as interacting with gravitational fields rather than bodies responsible for the fields. (1) Peat forms from plant remains in a stagnant swamp. For example, if the population of a growing city takes 12 years to
double from 10,000 to 20,000 inhabitants and its growth remains steady, in the next 12 years the population will double to 40,000, and in the next 10 years to 80,000, and in 
glass; speed 0.6c. Work may be done on the muscles by stretching and contracting, which is force times distance on a biological scale, but this work is not done on the harbell. Water molecules in this open structure have more space between them than they do in the liquid phase (Figure 6.19). also diverge when reflecting from the mirror. Discussiance on a biological scale, but this work is not done on the barbell.
your explanation. A dramatic example of warming by condensation is the energy released by steam when it condenses. FYI Because the voltage induced by the generators standardized so that the current goes through 60 full
cycles of change in magnitude and direction each second—60 hertz. What do the components of a conceptual model have in common? So a broader definition of the weight of something is the force at a slower speed, the cannonball would strike Earth's
surface; fired at a faster speed, it would overshoot a circular orbit, as we will discuss shortly. The deeper you swim, the greater the pressure. (b) N2F. Can you see from Figure 4.5 that for a sphere of radius 3 m, the thickness of the paint patch would be only 19 mm? Thus, when we look at the distribution of galaxies and superclusters of galaxies in
the universe today, we are looking at the world of quantum mechanics magnified to a universal scale. He needs to see the evidence for himself. An apple hanging from a limb has potential energy because of its height. H Phenol (acidic) Phenoxide ion Hydrogen ion \ge O \ge 499 O R G A N I C CO M P O U N D S O O \ge 400 You are probably most familiar
with the use of isopropyl alcohol as a topical disinfectant. Why is physics considered to be the basic science? An object that moves with twice the velocity of another object of the same mass has twice the momentum but four times the kinetic energy. Note that they The law of reflection. For more examples of pseudoscience, look to television or the
Internet. (a) The reaction should be placed in a vacuum. (c) a speeding bullet. But for protons that are far apart, such as those on opposite edges of a large nucleus, the attractive strong nuclear force may be weaker than the repulsive electric force. One type of motion of the stars is their nightly rotation as if they were painted on a rotating celestial
sphere; this is due to Earth's rotation on its own axis. They cover two-thirds of Earth's surface, forming a thin, extensive blanket over older igneous and metamorphic rocks. (b) 35 m/s. Ingesting only about 15 mL (about 3 Tbsp) of methanol may lead to blindness, and about 30 mL can cause death. Hewitt Nicole Minor/Exploratorium Lillian Lee
Hewitt/Paul G. Before the end of the hour, the room temperature increases to a comfortable level, even if heat is not provided by the heating system. By understanding nature at this level, we gain a deeper appreciation, and with deeper appreciation, and with deeper appreciation comes greater respect. The source of electromagnetic waves is vibrating (a) electrons. No one knows
exactly what impact nanotechnology will have on society, but we are quickly coming to realize its vast potential, which is likely to be much greater than that of microtechnology. Show that it could carry three, but not four, 400-kg crates. The tuning fork scatters the sound. The net force is 10 N - 2 N = 8 N (or more precisely 9.8 N - 2 N = 7.8 N).
Tornadoes are so frequent in this part of the country that many homes are built with underground storm shelters. So fish don't "breathe" water. Why are marchers following a band at the end of a long parade out of step with marchers near the front? Wet your finger and slowly rub it around the rim of a thin-rimmed, stemmed glass while you hold the
base of the glass firmly to a tabletop with your other hand. Diane Reindeau, shown on page 240, is another physics contributor. When discovered, these complementary links between electricity and magnetism created much excitement. The water will react with that base to produce more hydroxide ions. Openings appear black because the light that
enters them is reflected back and forth on the inside walls many times and is partly absorbed at each reflection. Conversely, the absorption of light can lead to an electric current, as in a solar cell. Science is about cosmic order. On average, the slope of a composite cone starts out at 30° at the summit and gradually flattens to 10° at the base. Note
that only the top string bears the weight of the ball. With higher temperatures, the color of the shrinking Sun will shift from red to blue, and its period? If Earth maintained the same speed, it would be compelled to break away from the Sun. As hot mantle rock rises, it
expands. Osmosis involves a semipermeable membrane. When findings in nature are expressed mathematically, they are easier to verify or to disprove by experiment. What is necessary, forcewise, to accelerate a system? When this occurs, the solute—sugar in this case—is said to have precipitated from the solution. Sticking and slipping of rock blocks
along the San Andreas Fault (really a zone of faults) generate many of the earthquakes California is noted for, including the great San Francisco quake of 1906. Show that the amount of light transmitted through a pane of window glass is at most 92%. + + CHECKPOINT Two protons in the atomic nucleus repel each other, but they are also attracted
to each other. A couple of your friends say that, before a falling body reaches terminal velocity, it gains speed while acceleration decreases. If you strike two slightly mismatched tuning forks, one fork vibrates at a different frequency from the other, and the vibrations of the forks are momentarily in step, then out of step, then in again, and so on. He or
she will see that it rotates once with each revolution. The Scientific Attitude 5. This form of cosmic radiation is harmful to living organisms. A 6-kg ball rolling at 3 m/s bumps into a pillow and stops in 0.5 s. Chilling hydrogen to its liquid phase, which occupies much less volume, poses similar problems. REVIEW 183 52. For now, we will restrict our
discussion to the general formation of magma from melting rock. While in the air, it maintains this forward motion, so the coin lands in your hand. 6.3 Heat 8. In what sense, therefore, can it be said that black-hole singularity does not exist? Place a coin over the center of the card. Amides contain the amide group, shown highlighted in blue. Galileo
defined the rate of change of velocity as acceleration: *Acceleration: *Acceleration = change of velocity time interval Acceleration: *Acceleration = change of velocity time interval Acceleration: *Acceleration = change of velocity time interval Acceleration: *Acceleration: *Acceleration = change of velocity time interval Acceleration: *Acceleration = change of velocity time interval Acceleration = 
Dissolving the salt in the water causes a decrease in temperature, which tells us that this is an endothermic (energy-absorbing) process. Alternatively, disinfecting iodine tablets can be used. Molecular oxygen, O2, consists of two oxygen atoms connected by four shared electrons. TUTORIAL: Light and Spectroscopy F I G U R E 11 .1 If you shake an
electrically charged object to and fro, you produce an electromagnetic wave. A ny path along which electrons can flow is a circuit. k = 9,000,000,000 N # m2/C 2. When do clocks move slowest on Mercury? (b) (a) F I G U R E 1 8 .1 3 (a) These two photographs show the same obelisk in New York City's Central Park before and after the effects of acid
rain. Planetesimals grew larger through countless collisions until they gravitationally dominated surrounding matter and finally became full-grown planets. Likewise, if you travel 320 km in 4 h, Average speed = 320 km total distance covered = = 80 km/h travel time 4h Note that when a distance in kilometers (km) is divided by a time in hours (h), the
answer is in kilometers per hour (km/h). Not so for light. Don't confuse this with radioactivity, a process of the atomic nucleus that we'll discuss in Chapter 13. This wave frequency remains the same as the bobbing frequency of the transfer of thermal energy
from a warm house to the cooler outside (in winter) and from the warmer outside to the cool house (in summer). 63 64 64 2 2 - 1 And if power generation continues to use predominantly fossil Consumption of nonrenewable resource EXPONENTIAL GROW TH AND DOUBLING TIME A-15 A B Time (a) (b) (c) FIGURE C.4 Consumption fuels, then except
for some improvements in efficiency, we would burn up in the next doubling time a greater amount of coal, oil, and natural gas than has already been consumed by previous power generation, and except for improvements in pollution control, we can expect to discharge even more toxic wastes into the environment than the millions upon millions of
tons already discharged over all the previous years of industrial civilization. You leap from a canoe that is moving away from the dock, reducing your speed relative to the dock, so your leaping distance is less than expected. Gravity and heat cause convection currents. 14.5 COOL Elements to Compounds EXPLAIN THIS A Physical change? From
 Pegasus you will see a "V" of stars that extends from the box to the left of Cassiopeia. This matter we can touch. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 19.1 Hydrocarbons 1. The quantity of heat given to the ice by the water is Q = cm \bigcirc T = (1 cal/g \# ^{\circ}C)(50 g)(80 {^{\circ}C}) = 4000 cal. Sugar, chemical name sucrose, is a compound
In Figure 5.31 the piston on the right has 50 times the area of the piston on the left (say the left has 100 cm2). A practitioner of "absent healing," for example, may truly believe in her ability to cure people she will never meet except through e-mail and credit card exchanges. Osmosis The net flow (diffusion) of water across a
semipermeable membrane from a region of low solute concentration. Because liquid water and water vapor are present nearly everywhere, chemical weathering is the main producer of sediment. Exothermic reactions spread energy out to the surroundings, much like C H A P T E R 17 H O W CH EM I C A L S R
E AC T 447 a cooling hot pan. Albert Einstein made this discovery. Why, then, is gravitation so intense near a black hole? Although most of Earth's crust is composed of igneous and metamorphic rock, the rock we see at the surface is mainly sedimentary. The food is only a receiver of radiation and is not transformed into an emitter of radiation, as can
be confirmed with a radiation detector. For example, F I G U R E 7.1 5 An IR thermometer measures the infrared radiant energy emitted by a body and converts it to temperature. Therefore, the blue scattered light is what predominates in our vision, so we see a blue sky! On clear, dry days, the sky is a much deeper blue than it is on clear, humid days
Violent motion, on the other hand, resulted from pushing or pulling forces. The degree and type of cleavage or fracture are useful guides for identifying minerals. The earth and planets spin in torque-free regions, and once they are spinning, they remain so. By how much, compared with the rod? (Walking or running barefoot across scorching sand in
daytime is a different experience from doing the same in the evening!) The low specific heat capacity of sand and soil, as evidenced by how quickly they cool at night, affects local climates. But don't touch the metal in the hot oven. To get an idea of how quickly they make the field of these magnets drops off, see
how many sheets of paper one of these magnets will hold on a refrigerator or any iron surface. Do the colors form by color subtraction? Thermal energy (kinetic plus potential) of the submicroscopic particles that make up a substance. Then explain it to them! 45. Newton's law of cooling The rate of loss of transfer
of thermal energy from a warm object is proportional to the temperature difference between the object and its surroundings: Rate of cooling of thermal energy from a warm object is proportional to the net force, and is inversely proportional to the
mass of the object. In 1964, scientists Arno Penzias and Robert W. Why do we see only one side of the Moon? Note that the curved arrows indicate the movement of electrons. Our astronaut would have performed her last experiment in the universe as we conceive it. What is a magnetic domain? When two Polaroid filters are arranged so that their
polarization axes are aligned, light can pass through both, as shown in the rope analogy (Figure 11.55a). pH A measure of the acidity of a solution, equal to the negative logarithm of the hydronium-ion concentration. This is analogous to a Christmas tree serving as the scaffolding on which ornaments are hung. —Arthur C. How does water pressure 11.55a).
m below the surface of a small pond compare to water pressure 1 m below the surface of a huge lake? So the hexagonal structure at the surface is weakened and collapses into a thin liquid film, nice for ice skaters. With unaided eyes, we see the Milky Way as F I G U R E 2 7. And magma forms when rock melts. The time-slowing effect of gravity,
however, has since been observed and accurately measured in white dwarf stars, which are dimmer and have gravitational fields much stronger than that of our Sun. What rule of nature is at play here? Blue stars are hottest, then white stars, and red stars are coolest. The late Jean Curtis demonstrates magnetic levitation on page 227. The change in
distance, therefore, was 45 mm over a time of 1 s. From c = f l, l = = 5 * 10-7 m, or 500 nm. During the past hundred years, for example, the theory of the atom has been repeatedly refined as new evidence on atomic behavior has been gathered. and atmosphere! 20 C H A P T E R 2 0 Rocks and Minerals O ur earth is an interconnected 20. More
than 200 years later, Albert A. The definition of molarity refers to the number of liters of solvent. More important than defending beliefs is improving them. At night, while you are lying prone, relaxation undoes the compression and you get taller! 97. Emily holds a banana of mass m over the edge of a bridge of
height h. 7 Molecular Polarity 15. Earth's center is the far focus. The amount of current produced by electromagnetic induced Voltage induced = number of loops: CHAPTER 9 M AG N E T I S M A N D E L E C T R O M AG N E T I C I N D U C T I O N 227
 voltage.* For example, we can plunge a magnet into and out of a closed rubber loop and into and out of a closed loop of copper. CHAP TER 26 THE SOL AR SYSTEM 727 202 8 20 Ju 0 9 l. inch degree Celsius J joule calorie K kelvin electron volt kg kilogram degree Fahrenheit lb pound foot m meter M min mph N Pa psi s V W \ molarity minute mile
per hour newton pascal pound per square inch second volt watt ohm 4.6 Fast-Moving Projectiles—Satellites 20. How can a solution be separated from a suspension? Its frequency is 2 Hz. The time needed to complete one vibration—is 12 s. When the atoms of your hand push against the atoms of a wall, electrical
repulsions between electrons in your hand and electrons in the wall prevent your hand from passing through the wall. Some of its neutrinos were detected on Earth. We think we understand how compound interest works, but we can't get it through our heads that a fine piece of tissue paper folded upon itself 50 times (if that were possible) would be
more than 20 million kilometers thick. In boxing, why is it advantageous to roll with the punch? The starches within the kernel are also cooked by the high temperatures, and this is an example of a chemical change. To solid-waste disposal site remains in the water for an extended time after leaving the facility. How fast does the heavier cart roll
compared with the lighter cart? It is this oxygen at high concentrations at the site of the injury that kills off microorganisms. Does this indicate that prolonged exposure to aspirin increases a person's risk of developing cancer? In equatorial regions, the Sun's rays are concentrated as they strike perpendicular to Earth's surface. Generally, when two
galaxies collide, they sideswipe each other. Is government really necessary to enforce these regulations? Suspension A homogeneous mixture in which the various components are finely mixed, but not dissolved. (d) none of these 4. After 1014 years, all stars will have exhausted all possible fuel. As silver tarnishes, it is oxidized (Ag S Ag+ + 1 e-). If
 equal quantities of heat are given to equal masses of aluminum and copper, the metal that more rapidly increases in temperature is (a) aluminum. Ping-Pong balls in Earth F I G U R E 1 2 .1 8 ? H H H C C H H H H Diethyl ether, boiling point 35°C F I G U
R E 1 9 .1 5 Diethyl ether is the systematic name for the "ether" historically used as an anesthetic. (d) any of these 8. (b) If the initial acceleration will be 1.0 m/s2. Your knowledge is much greater, and being aware of the amazing possibilities that science
continues to reveal puts you in a very privileged minority. Why are apples gravitationally attracted to Earth? Why is color not always the best way to identify a mineral? (d) depends on temperature. (a) From fastest to slowest, rank their terminal velocities. So gaining an electron results in a negative ion, and losing an electron results in a positive ion.
Petroleum formation begins with the accumulation of sediment from areas rich in plant and animal remains. (b) What is the landing speed if the wind is a tailwind, coming from behind the plane? Einstein hypothesized that light is bent by gravity. An echo is weaker because sound spreads and is therefore less intense with distance. The water in the pot
is being cooled by boiling as fast as it is being heated by energy from the heat source (Figure 7.29). Could this technique have worked if they had been carved on stone tablets? (Hence the name giant.) Above the giants on the H-R diagram are a few rare stars, the supergiants. If you place a chunk of iron near the north pole of a magnet, attraction will
occur. Net force on the scaffold is zero, so we say it is in mechanical equilibrium. The particles can vibrate about fixed positions, but they cannot move past one another. Sublimation The change of phase directly from solid to gas. Historically, there has been a misunderstood association between entropy and disorder, but now you know better. 25.3
Cloud Development Why do some clouds form as layers, while other clouds seem to form as towering castles? Upon ignition, these two liquids mix and react chemically to form water vapor, which produces the needed thrust as it is expelled out the rocket cones. In our sucrose example, this means that the sweetness of the first sip of the solution is the
same as the sweetness of the last sip. Paul is seen with Lillian on page 52, and Lil appears again on page 52, and with her pet conure, Sneezlee, on page 279. Just go outside, look up at the sky, and with good eyesight every minute or so you will see a shooting star. The specific heat capacity of ice is about 0.5 cal/g # °C. A similar
polymer, Bakelite, made from formaldehyde and phenols that contain multiple oxygen atoms, is used to bind plywood and particle board. Because these electrons are not held very tightly, they are easily lost, which is why the magnesium atom tends to form the 2+ ion. Something painted blue absorbs yellow, so it reflects all the colors except yellow.
But suppose the density of air were a constant 1.2 kg/m3. Dogs have no sweat glands (except between the toes for most dogs) and therefore they cool by the evaporation of moisture from the mouth and the respiratory tract. A material that does not dissolve in a solvent to any appreciable extent is said to be insoluble in that solvent. a, 4. O OCH 3 58
phase, shake the O D D - N U M B E R E D S O LU T I O N S balloon very gently so that the beads remain together but tumble over one another. Rank the following from greatest to least: (a) the magnitude of Jake's momentum relative to an observer at rest on the ground. A bowling ball rolling along a
 lane gradually slows as it rolls. Why does the card stay in place? The result is a net alignment of domains along the length of the nail. The straight dashed line represents the "home" position, or speed. How many molecules of aspirin (formula mass = 180 amu) are there in a 0.250-g sample? Episodic and unusually voluminous CHAPTER 20 R O CK S A
N D M I N E R A L S 537 F I G U R E 2 0 .1 8 The flood basalts that produced the Columbia Plateau covered more than 200,000 km2 of the preexisting land surface. Aspirin is made from salicylic acid. So just as there is water and ice, there is magma and rock. The color violet is seen where the angle between the sunbeams and dispersed light is 40°
Applied research in chemistry has provided us with medicine, food, water, shelter, and many of the material goods that characterize modern life. Is the force of friction equal and oppositely directed to your 200-N push? 4 Express the numeric value of the atomic mass of any element in grams, and that many grams contains 6.02 * 1023 atoms.
 Radioactive decay rates are statistical averages from large numbers of decaying atoms. But if it were fired fast enough to attain circular orbit, gravity would not change its speed at all. Even though it momentarily stops at the top, the net force on the ball is not zero and it therefore is not in equilibrium. The air at this elevation is quite cold and dry,
and so clouds this high are made up almost entirely of ice crystals. Paint spray travels radially away from the nozzle of the can in straight lines. This alternate pathway involves two steps. At 100°C, the atoms are farther apart,
meaning that each milliliter now contains fewer atoms than at 25°C, and the density is now 13.35 g/mL. There's concern about how clean a container must be before it can be recycled. However, it differs in direction. For example, a black hole resulting from the collapse of a star 10 times as massive as the Sun has an event-horizon diameter of about
30 km. Doesn't this show the same physics concept as in the preceding activity? We can see their different structural features by highlighting the carbon framework in two dimensions. On April 18, 1906, the Pacific Plate lurched about 6 m northward over a 434-km stretch of the fault, releasing the built-up stress and resulting in the catastrophic San
Francisco earthquake. Because he published his findings in Italian instead of in Latin, which was expected of so reputable a scholar, and because of the recent invention of the printing press, his ideas reached many people. VIDEO: Free Fall Acceleration Explained change of velocity 5 km/h = 5 km/h # s = time interval 1s change in speed 10 m/s = 10 m/s 
10 m/s # s = 10 m/s2 time interval 1s We read the acceleration of free fall as 10 meters per second squared. (b) - 273°C. A friend reasons that the table can't push upward on the book because if it did, the book would rise above the table. In a circular orbit, the force of gravity is everywhere perpendicular to the satellite's motion. or, in equation
notation, Fd = 1 2 FIGURE 3.20 mv2 Note that the speed is squared, so if the speed of an object is doubled, its kinetic energy is quadrupled (22 = 4). Although both contain oxygen, gaseous o
been operating. That's right—everything! Absorption of Radiant Energy If everything is radiating energy, why doesn't everything finally run out of it? The coefficients in this balanced equation tell us the ratio in which reactants react to form products. And where will all the matter fly off to? Why does the composition of magma change as it cools?
Catalytic converters, along with microchipCatalytic converter controlled fuel-air ratios, have led to a significant drop in the per-vehicle emission of pollutants. Color is a physiological experience and is in the eye of the beholder. Most light incident on a pane of glass, for example, is transmitted through the pane. The Laboratory Manual for Conceptual
Physical Science is written by the authors and Dean Baird. What does it mean to say that a solution is concentrated? Its boiling point is - 34:1. Hewitt 247: Paul G. Any substance that can do work through chemical action possesses potential energy.
 ions. (b) A carbon atom attracts the four electrons in four hydrogen atoms to form methane, CH4, the primary component of natural gas. Moon Moon 's orb Node Sun Eclip it Node Earth's umbral shadow (a) 26.6 (b) Failed Planet Formation If an asteroid and a comet of equal mass were on a collision course toward Earth, the
distinct periods. When the bimetallic coil expands, the drop of liquid mercury rolls away from the electrical contacts and breaks the electrical circuit. 94. 197 FIGURE 8.20 Each coulomb of charge that is made to flow in a circuit that connects the ends of this 1.5-V flashlight cell is energized with 1.5 J. Beats can occur with any kind of wave, and they
can provide a practical way to compare frequencies. Many books manufactured in the days before "acid-free" paper smell of vanilla because of the vanillin formed and released as the paper ages, a process that is accelerated by the acids the paper smell of vanilla because of the vanilla because of t
238: Paul G. If you've ever compressed air with a tire pump, you probably noticed that both the air and the pump became quite hot. Star B is twice as far, which is 200 light-years. What is meant by the term supernatural? Chlorine, Cl2, is a gas at room temperature, but bromine, Br2, is a liquid. So now you know why you can dry yourself with a towel
much more comfortably if you remain in the shower stall. The captured electric energy of the battery is subsequently used to assist the gaspowered engine to get the car moving. Use the bond energies in Table 17.1 and the accounting format shown in Section 17.5 to determine whether these reactions are exothermic or endothermic. H (a) N H C 3 Hore the car moving.
8 O h C 3 H 6 + H2 O 39. A similar situation occurs in molecules in which polar covalent bonds are not equal and opposite. Before you know it, the remaining visible stars quickly pass through their life spans, their light coming to you in a flash of ultrahigh frequencies but through a narrowing field of view. Solution: 1200 W = 1.2 kW; 1.2 kW * 1 h *
30./1 kWh = 36.. In other words, the electron doesn't "jump" from a higher to a lower orbit the way a squirrel jumps from a higher branch in a tree to a lower one. Interestingly, neutrons are not stable when they are by themselves. By how much would its speed readings increase with each second of fall? And when sedimentary rock is buried deep
within Earth or involved in mountain building, great temperatures and pressures can transform it into metamorphic rock. Another common unit of heat is the British thermal unit (Btu). Bohr saw this as similar to how the planets are held in orbit around the Sun at given distances from the Sun. As the syrup hits the snow, it warms the snow, causing it
to melt while the syrup becomes more viscous. Secondary treatment decreases the biochemical oxygen demand of the effluent by aeration. Why do exothermic reactions typically favor the formation of, 671 deep-water currents in, 676 surface
currents in, 672 Second law of thermodynamics, 150 Secondary waves (S-waves), 556-557 Sedimentary rocks, 533, 539-544 chemical, 543 classification of, 542-543 formation of, 543-544 in rock cycle, 548-549 Sedimentary rocks, 530, 539-544 chemical, 543-544 in rock cycle, 548-549 Sedimentary rocks, 530, 539-544 chemical, 543-544 in rock cycle, 548-549 Sedimentary rocks, 530, 539-544 chemical, 543-544 in rock cycle, 548-549 Sedimentary rocks, 530, 539-544 chemical, 543-544 in rock cycle, 548-549 Sedimentary rocks, 530, 539-544 chemical, 543-545 in rock cycle, 548-549 Sedimentary rocks, 556-557 Sedimentary rocks, 530, 539-544 chemical, 543-544 in rock cycle, 548-549 Sedimentary rocks, 556-557 Sedimentary rocks, 5
Selective transmission, of light, 276-277 Semipermeable membranes, 416 Series circuits, 202-203 Shell model, of atom, 313-315, 368-369 Shield volcanoes, 537 Shock, electric, 200-202 Shock waves, 253-254 Shorelines, waves and, 653-657 Silicates, 528 Silurian period, 631-632 Sinkholes, 599 Sky, color of, 280 Slate, 547 Soaps, 409-410 hard
water and, 411-413 Solar eclipse, 726, 727-728 Solar energy, 80, 662-666 greenhouse effect and, 664-666 seasons and, 663-664 terrestrial radiation and, 664-666 seasons and, 663-664 terrestrial radiation and, 664-666 greenhouse effect and 664-
associated with your momentary stops. At this temperature, the liquid water readily transforms to water vapor, but the sodium chloride stays behind dissolved in the remaining water. Heteroatom Any atom other than carbon or hydrogen in an organic molecule. Note that because the name Einstein is generally held in high esteem, it is a favorite of
pseudoscientists. (c) centripetal. A filing cabinet, a refrigerator, and even cans of food on your pantry shelf have north and south poles induced by Earth's magnetic field. Will they have the same acceleration? But the density of surrounding air decreases. It is easy to confuse the ideas of mass and weight. When pumping a swing, you pump in rhythm
 with the natural frequency of the swing. Projects for wingsuit flyers to land without a parachute, however, are under way. Every object continues in a state of rest or of uniform speed in a straight line unless acted on by a nonzero force. You won't hear the Doppler shift, but your friends off to the side will. 2 A-2 APPENDIX A F I G U R E A .1 The ball
rolls 1 m down the incline in 1 s and reaches a speed of 2 m/s. ©d 5 km 49. The patina is not copper, it is not water. (b) How do their accelerations compare? What is the speed of the plane relative to the speed of sound? Streak The name given to the color of a mineral in its powdered form. They place a tall tin coffee can of
height 0.1y on the floor to catch the ball. Over the next billion years tidal forces slow the rate of Earth's rotation while also causing the Moon to move farther away. The lever arm about any axis of rotation is the perpendicular distance from the axis to the line along FIGURE A.6 If you move the weight away from your hand, you will feel the difference
between force and torque. (Hint: Think momentum conservation.) 116. When the magnetic field strength diminishes (as the magnet leaves), the voltage is induced in the opposite direction. What do these types of forecasting mean? But perpetual motion itself is a yes-yes. Whereas the speed of a satellite is constant in a circular orbit, its speed varies Aprel 116.
simple method for constructing in an elliptical orbit. 4 Acceptance of Continental Drift 21. North America Europe Asia Africa Equator South America Europe Asia Africa Europe A
be modeled as particles connected to the atomic nucleus by springs. Testosterone: alcohol and ketone. The pencil should rotate in a counterclockwise direction—like a Northern Hemisphere midlatitude cyclone. For example, a quartz crystal because quartz is harder than feldspar. From Coulomb's law, the force is given
by F = 2, so the square of the d (20 N)(0.06 m)2 Fd 2 = 8.0 * 10 - 12 C2. So induction occurs whether or not a conducting wire or any material medium is present. Regarding Exercise 84, if one thrower. For example, put room-temperature water
in a vacuum and it will boil. 392 PA R T T W O CH E M I S T RY 15.8 Molecular Attractions 24. How does this compare with the heat needed to raise the temperature of the same mass of water through the same temperature difference? The farther away you are from a luminous star, the dimmer it appears. gt 2 1 t 2 1 t 2 . But inanimate things can do
likewise. The density of mercury is 13.6 times the density of water. You can test this yourself: Throw a heavy boulder horizontally, then at an angle upward—you'll find the horizontally faster. Does air cool as it expands? When just above you, it should fly at 3 m/s in order to hover at rest. Continue breaking the pieces further and
nonsilicates. CHECKPOINT Stable air that is forced to rise spreads out horizontally. This has a negative effect on the fish. (b) If Lillian's average speed is 7.5 m/s for a time of 5.0 min, show that she travels a distance of 2250 m. For larger molecules, which can have numerous orientations, this orientations, this orientations, this orientations, this orientations are concentrated a sample of nitrogen and
oxygen, the greater the tion requirement is even more restrictive. PROLOGUE In science, it is more important to have a means of proving an idea wrong than to have a means of proving an idea wrong than to have a means of proving an idea wrong than to have a means of proving anditional devices increases the current still more. FYI 430 PA R T T W O CH E M I S T RY CHECKPOINT Write a balanced equation for the
reaction showing hydrogen gas, H2, and nitrogen gas, N2, forming ammonia gas, NH3: ___H2(g) + ___N2(g) h ___NH3(g) Was this your answer? A conceptual model describes a system. One joule of work is done when a force of 1 m, as in lifting an apple over your head. Claims that are presented as scientific but do no
meet these standards are what we call pseudoscience, which literally means "fake science," In the realm of pseudoscience, skepticism and tests for possible wrongness are downplayed or flatly ignored. A pair of skaters initially at rest push against each other so that they move in opposite directions. The electron vibrates back and forth between
different energy levels. 633: (top) Lynette Cook/SPL/ Photo Researchers, Inc. The pH of this solution is the negative log of this number, or 6.77. It is the only existing photo of the full Earth from an appreciable distance. Zinc has a low melting point, which makes it easy to remove from the inside of the penny. Iron is forced to accept electrons from
either zinc or magnesium atoms. VIDEO: Pressure Cooker: Boiling and Freezing at the Same Time Mountaineering pioneers in FYI the 19th century, without altimeters, used the boiling point of water to determine their altitudes. Totality begins when the Sun disappears behind the Moon, and ends when the Sun reappears on the other edge of the
aura that extends through space.* If you place a charged particle in an electric field, it experiences a force. Is it fair that developed nations mandate through international treaties that developed national treaties that developed national treati
Clu Nah Clu h Sodium chloride crystal u h Na Cl Clu Nah Clu Na
steam, it is piped to a turbine at the surface. The difference in brightness between the Sun and Moon, for example, is about 1 million to 1. FIGURE 1.3 The motion of balls on various planes. The Abundance of Hydrogen and Helium Where exactly did the Big Bang occur? 7 INTERACTIVE FIGURE During a reaction, reactant molecules collide with one
another. Weathering breaks down and decomposes surface rock. But no machine can multiply work or multiply energy. On a normal noneclipsed sunny day, these spots beneath a tree are round because the Sun is round. Although no cookbook description of the scientific method is really adequate, some or all of the following steps are likely to be
found in the way most scientists carry out their work. As you read this answer and act out your movement around the solar beach ball, envision writing "New York City" on your left arm and "Los Angeles" on your right arm. As we will see in this chapter, the macroscopic properties of any substance can be traced to how its submicroscopic parts are
held together. FIGURE 9.25 It is more difficult to push the magnet into a coil with many loops because the many loops b
Hydrogen fluoride H2O h Potassium hydroxide Hydrogen chloride + Sodium hydroxide 459 What makes one acid strong and another weak? At the time of Hubble's observations, astronomers could calculate the luminosity of a Cepheid from its periodic changes in brightness. What must be the minimum length of a vertical plane mirror in order for you
to see a full view of yourself? Our global climate is changing. Toward this end, smokestacks have been designed or retrofitted to minimize the quantities of pollutants released. This and all other chemical compounds cannot be
readily distinguished. FIGURE 26.35 Were these your answers? If the bulbs are connected in parallel? FYI CHECKPOINT Iron's normal melting point is 1535°C, yet Earth's inner core temperature is at least 5000°C. An acid and a base react to form a salt, which consists of positive and negative ions. So is the universe as a whole curved? What is
electrochemistry? Less than a thousand years later, the Moon's accretion is rapidly nearing its end, and relatively little debris still remains? Then her lever arm is 2.5 m. cience and technology are also different from
each other. Which ball, the one fired downrange or the one dropped from rest, strikes the ground first? The most common types of metamorphism and regional metamorphism and regional metamorphism and regional metamorphism and regional metamorphism. The core of Jupiter was the first to develop, and hence it had the longest time to collect gas before solar ignition. 1 PAT T E R N S O F M OT I O N A
N D E Q U I L I B R I U M A P P R OX I M AT E S P E E D S I N D I F F E R E N T U N I T S 12 mi/h = 40 \text{ km/h} = 120 \text{ km/h} = 120 \text{ km/h} = 20 \text{ km/h} = 120 \text{ km/h
(batted softball) 100 mi/h = 160 km/h = 44 m/s (batted baseball) Any combination of units for distance and time can be used for speed—kilometers per hour (km/h), centimeters per day (the speed of a sick snail), or whatever is useful and convenient. (d). (Don't confuse a radio wave with the sound that a loudspeaker emits.) 11.2 Transparent and
Opaque Materials LEARNING OBJECTIVE Relate the transparency of materials to wave frequencies. If the composition of the upper atmosphere were changed to permit a greater amount of terrestrial radiation to escape, what effect would this have on Earth's climate? (d) Compared to the billions of water molecules, a thousand molecules.
weather maps. At the time of the transistor's invention, few people realized the impact microtechnology would have on society—from personal computers to cell phones to the Internet. 2 2 As the diver dives, his potential energy is converted into kinetic energy. Light is slowed because of the absorption/re-emission sequence, and the closer to the
resonant frequencies, the slower the light. For both electricity and gravity, a force field exists that influences distant charges and masses, respectively. What was the iron of the nail able to do for the copper ions? A more massive object, therefore, can have a smaller volume. Hydrogen peroxide, H2O2, is a relatively unstable compound. In 2004,
spacecraft orbiting Mars detected signs of the organic compound methane, CH4, within the atmosphere. The work required is the same in both cases: (50 kg)(4 m). There is science in everything you see, hear, smell, taste, and touch! LEARNING OBJECTIVE Relate technology to the furthering of science, and vice versa. When a steadily
flowing gas flows from a largerdiameter pipe to a smaller-diameter pipe, what happens to (a) its speed, (b) its pressure, and (c) the spacing between its streamlines? s described in Chapter 12, the atomic nucleus occupies only a tiny fraction of the volume of the atom, leaving most of the atom as empty space. When iron parts of a car move over the
buried coils, the effect of Earth's magnetic field on the coils is changed, inducing a voltage to trigger the changing of the traffic lights. Pressure! Because of these intense conditions, the hydrogen, helium, and minute quantities of other elements exist in the plasma state. (Note: The units kg
# m/s2 and N are equivalent.) 56 PARTONEPHYSICSTHINKANDSOLVE (MATHEMATICALAPPLICATION) 38. For a freely falling object dropped from rest, what is its acceleration at the end of 5 s? 11,000 people missing)! Look at Figure 21.37 and you will see how these devastating earthquakes align with plate boundaries.
What other two products result from this electrolysis reaction? Keeping the quarter fixed, revolve the penny around it in such a way that Lincoln's head is always pointed to the center of the quarter fixed, revolve the penny around it in such a way that Lincoln's head is always pointed to the center of the quarter fixed, revolve the penny around it in such a way that Lincoln's head is always pointed to the center of the quarter.
folding (Figure 21.30). Paul's sister (and John's mom) Marjorie Hewitt Suchocki (pronounced Suhock-ee, with a silent c), a leading process theologian, is shown reflectively on page 270. What does the Big Rip scenario assume about dark energy? 9 These radiation curves for stars of the same size and different surface temperatures show two important
facts: (1) hotter stars emit radiation with higher average frequency than cooler stars, and (2) hotter stars emit more radiation per unit surface area at every frequency than cooler stars. The winning team pushes harder against the ground. Hewitt 70: Paul G. The hundreds of power plants built in the United States prior to 1900 adopted 110 V (or 115
or 120 V) as their standard. (b) convects well. Mirages are a common sight on a desert when the sky appears to be reflected from water on the distant sand. (b) results in a straight line. You produce a longitudinal wave with your Slinky when you shake it back and forth along the Slinky's axis (Figure 10.6a). When the condensation rate is greater than
the evaporation rate, what happens to the air? The precise volume of water in a beaker depends on the temperature of the water. There are zillions of galaxies we don't see because the universe is not old enough for their light to have reached us. Discuss which field performs which function. The net force is 5 N, because \boxtimes F = 65 N · 60 N. How would
you explain it? When the film was reversed, the train was seen to move toward the heroine. If one of the tennis balls is filled with lead pellets, will it fall faster and hit the ground first? A crab lives at the bottom of its ocean floor and looks upward at jellyfish and other lighter-than-water marine life drifting above it. With less carbon dioxide in the
 atmosphere, the greenhouse effect would be minimized and Earth would cool. As evaporation progresses, the temperature of the water in the cloth drops and cools the bottle to a temperature below that of the water in the bucket. When the uranium nucleus splits in half, however, smaller nuclei of lower atomic numbers are formed. The main
component of bleach is sodium hypochlorite, NaOCl, which consists of sodium ions, Na +, and hypochlorite ions, - OCl. What products are formed when this compound reacts with the hydrochloric acid, HCl, of toilet bowl cleaner? You may recall that this organic compound was used as an example of a weak acid back in Chapter 18. Consider how
many protons fit within the dimensions of Earth. How are ketones and aldehydes related to each other? (Or, more simply, the planes can be represented by vectors in two mutually perpendicular directions, as shown in Figure 11.53c.) The vertical directions, as shown in Figure 11.53c.)
developed by Linus Pauling to explain chemical bonding and the organization of the periodic table. About 91% of the atoms in the universe are estimated to be hydrogen. Another, shown in Figure 18.30, is passing an electric current through water, a process that breaks the water down into its elemental components: Electric energy + 2 H2O(l) h 2
that occurs once every 15 to 17 years, its bright, ruddy color outshines the brightest stars. This halo may measure up to 10 times the diameter of the luminous galaxy and be about six times as massive. Consider three 1-g samples of matter: (a) carbon-12, (b) carbon-13, and (c) uranium-238. In fact, as just discussed, 1 s after the ball leaves the
pitcher's hand it has fallen a vertical distance of 5 m below the dashed line—whatever the pitching speed. Show that the vacationer's average density is 923 kg/m3. Interestingly, most of the damage was due to the fires that burned the city afterward. A heavy crate accidentally falls from a high-flying airplane just as it flies directly above a shiny red
 Porsche smartly parked in a car lot. When a room becomes too cold, the coil bends toward the brass side and activates an electrical switch that turns on the heater. Figure 18.23 shows how a salt bridge allows the ions it holds to enter either container, permitting the flow of electrons through the conducting wire and creating a complete electric
circuit. What does this have to do with the darkness of rain clouds? Place a small rubber ball on top of a basketball or soccer ball and then drop them together. 65: (top) Paul G. Supermassive stars, therefore, burn out in short periods of time, such as a few million years. Upon cooling, the canary color returns, suggesting that the change is physical.
Electric power is equal to the product of current and voltage: *Power = current *voltage is expressed in watts. As the hand upward, in accord with Newton's third law. 110. When the average pressure difference over the
 wing is multiplied by the surface area of the wing, we have a net upward force—lift. In 1 s you stretch the rubber band to 10 times its original length. As strange as it may seem, maximum speed for most sailcraft in a direction upwind! Although a sailboat cannot sail directly
upwind, it can reach a destination upwind by angling back and forth in a zigzag fashion. Quasar The core of a distant galaxy early in its lifespan when its central black hole has not yet swept much matter from its vicinity, leading to a rate of radiation greater than that from entire older galaxies. Radon seeping into the canister is adsorbed by activated by activate
carbon within the canister. Place a heavy book on a table and the table pushes up on the book. One solution to the problem of our overflowing landfills is to burn plastic objects instead of burying them. It may or may not involve elevated temperatures. We will share the same fate as our sister planet Venus. The sound energy that is not reflected is
transmitted or absorbed. The first catalog is based on the work of Charles Messier, who in 1781 published a list of heavenly structures, such as galaxies, relatively easy to observe with small telescopes. Most things around us are opaque—they absorb light without re-emission. 384 PARTWOCHEMISTRY HOOHHH (a) (b) FIGURE 15.29 (a)
The individual dipoles in a water molecule add together to give a large overall dipole for the whole molecule, shown in purple. This system is designed so that a compound's name reflects the elements it contains and how those elements are joined. A 100-g chunk of 80°C iron is dropped into a cavity in a very large block of ice at 0°C. Evaporities
precipitate out of water solutions in a way that is very similar to the crystallization of minerals from magma. What do the compounds cyclopropane and propene have in common? Most consumer goods can trace their origins to acid- base chemical reactions. We then reasoned that the tension in my rope would gradually decrease as I walked toward
 Burl. Because each blue jelly bean has twice the mass of each red one, the clerk needs to measure out twice as much mass of blues in order to have the same count, which means 10 lb of blues. Technology—The Practical Use of Science EXPLAIN THIS S Who thinks of an idea, who develops it, and who uses it? Do compressions and rarefactions in a
sound wave travel in the same direction or in opposite directions from one another? The 4 million tons of mass lost is discharged as radiant energy. An H-R diagram is a plot of intrinsic brightness versus surface temperature for stars. EXPLAIN THIS N 0 1000 Crust 3000 Mantle 4000 Depth (km) 2000 5000 Outer core Inner 6000 core Speed (km/s)
 21.2 557 13 12 11 10 9 8 7 6 5 4 3 2 0 ave P-w P-wave ve P-wa S-wave No S-waves in outer core 1000 2000 3000 4000 5000 6000 ear the beginning of the 20th century, Irish geologist Richard Oldham was examining records of a massive earthquake in India when he discovered that its S-waves traveled some distance through Earth and then stopped
For example, the Cypress Freeway structure collapsed, and many homes in San Francisco's Marina District were severely damaged. Is the corresponding force of the bug on the bus greater, less, or the same? Natural philosophy was the study of unanswered questions about nature. Be sure to try this activity if you haven't already. If you wish to save
fuel and you're going to leave your cool house for a half-hour or so on a very hot day, should you turn your air-conditioning thermostat up a bit, turn it off altogether, or let it remain at the room temperature you desire? What is the purpose of the copper or aluminum layer on the bottom of a stainless-steel pot? So, to cool a bottled beverage at a picnic,
wet a piece of cloth in a bucket of cool water and then wrap it around the bottle. Hewitt 230: (bottom) Lillian Lee/Paul G. A car, for example, may travel along a street at 50 km/h, slow to 0 km/h at a red light, and speed up to only 30 km/h because of traffic. A bat flying in a cave emits a sound and receives its echo 0.1 s later. The metals industry mines
these ores from the ground, as shown in Figure 15.14, and then processes them into metals. DISCUSSIONQUESTIONS (EVALUATION) 76. First, consider air pressure. We may do 100 J of work but get out only 98 J. When water evaporates from a body of water, what type of mineral is formed? Spring tide A high or low tide that occurs
when the Sun, Earth, and Moon are aligned so that the tides due to the Sun and Moon coincide, making the tides higher or lower than average; occurs during the full Moon or new Moon. 20 amperes, but no more. Hold the ends of the wire close together, but not touching, and place the ends on your tongue. Red is scattered the least, and it passes
through more atmosphere than any other color. The fact that impulses are greater when bouncing occurs was used with great success during the California gold rush. They reflect all of the light. Channel geometry The shape of a stream channel; the cross sectional area. Or, if the object is projected upward, the vertical distances of travel decrease
with time on the way up. Rank the following stages of sedimentary rock formation from first to last: (a) erosion. (b) lithification, (c) weathering, (d) deposition. Cut bank A steep bank on the outside bend of a river's channel; an area of erosion. (e) weathering, (d) deposition. Cut bank A steep bank on the outside bend of a river's channel; an area of erosion.
object—and the tennis ball is a freely falling object (as is every projectile when air resistance can be neglected). Is technology the source of happiness? With this major accomplishment in mind, discuss the relative merits of specializing in a single area versus becoming an expert in many different areas. Input energy? FIGURE 9.37 In turning the crank
of the generator, Sheron Snyder does work, which is transformed into voltage and current, which, in turn, are transformed into light. An earthquake is the shaking or trembling of the ground that happens when rock under Earth's surface moves or breaks. Does wave speed change? By passing white light through a prism or through a diffraction
grating, we can separate the color components of the light, as shown in Figure 12.21. Rank the following properties used for mineral identification from most useful: (a) color, (b) hardness, (c) streak, (d) cleavage. The distance from the Sun to the outer edges of the Oort cloud (the full radius of our solar system) is about 0.8 light-year.
 What does this have to do with the whiteness of clouds? At the deepest level, scientists don't know the answers to these questions—at least not yet. The brightness of each lamp is unchanged as other lamps are introduced (or removed). If little remains, the acid or base is strong. 9 Expansion of Water a cup of hot tea and a cup of cool tea? How is it
different? First you need to understand that 2 M means 2 moles of sucrose per liter of solution. THE ATO MICN UCLEUSANDRADIOACTIVITY A more important graph results from the plot of nuclear mass per nucleon from hydrogen through uranium (Figure 13.30). The slightest disturbance will send it off into spare or spiraling into the
black hole.* An indestructible astronaut with a powerful enough spaceship could venture into the photon sphere of a black hole and come out again. Second law of thermodynamics Heat never spontaneously flows from a cold substance to a hot substance. Ammonia indirectly increases the hydroxide-ion concentration by reacting with water: NH3 +
strengthen, the magnet.) 51. But with a difference—electrons (whereas gravitational forces only attract). The material with the shorter half-life is more active and shows a higher counting rate on a radiation detector. Fatty acid molecules can also
align to form a bilipid layer that extends in three-dimensions. The consequences should be absent if the hypothesis is not correct. Hewitt Dean Baird/Paul G. The Sun contains what percentage of the solar system's mass? Speed The distance traveled per time. Suppose, for example, that a pendulum makes two vibrations in 1 s. After a minute or so, the
penny will appear to blister. Hewitt 267: Paul G. It was via Burl that I met my teaching role model, futurist Jacque Fresco, the most talented teacher I've ever met. When a cannon with a longer barrel is fired, the force of expanding gases acts on the cannonball for a longer distance. (c) either or both of these (d) none of the above 4. Why is it a good
idea to extend your bare hand forward when you are getting ready to catch a fast-moving baseball? F = G \ 2 \ d \ (6.0 * 1024 \ kg)(2.0 * 1030 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 * (1.5 * 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 \times (1.5 \times 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 10 - 11 \ N \ \# m^2 > kg^2 \times (1.5 \times 1011 \ m)^2 = 3.5 * 1022 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.67 * 1020 \ N \ (3.0 \ kg)(100 \ kg) = 6.
672-673 Corrosion, 479-481 Cosmic background radiation, 772-773 Cosmic inflation, 775-777 Cosmology, 769-777. Helium, chlorine, argon. We can use molecular attractions to separate the components of black ink through a technique that is called paper chromatography. For example, as illustrated in Figure 17.3, the
mass of carbon is 12.011 amu. With higher octane fuels, not only do you lose performance, but you lose your money as well. The photo, however, is a mixture of only cyan, yellow, magenta, and black (CYMK). By the time the three minutes of helium synthesis were over, the universe would be left with about 75% hydrogen and 25% helium, which is
what we observe in the universe today. Atomic masses are averaged by isotopic abundance on the Earth's surface, expressed in atomic mass units. The inset shows the internationally used symbol indicating an area where radioactive material is being handled or produced. Although low- and medium-mass stars become white dwarfs, the fate of stars
more than about 10MSun is quite different. Mass: The quantity of matter in an object. In place of isopropyl alcohol, washcloths wetted with cold water are nearly as effective in reducing fever, and they are far safer.) C H A P T E R 19 O S O F I G U R E 1 9 .1 2 H The negative charge of the phenoxide ion can migrate to select positions on the
benzene ring. Examples of pros and cons are open ended. Because the ship is so large, these 10 passengers could easily congregate to one side. The density of the air in the tank is 1.25 kg/m3. If your friend doesn't understand the result, ask him or her what would happen if you had added the sugar to the glass when the glass was full of water. So it
takes Earth longer than a day to spin around once! 55. A gas-filled balloon rises only so long as it displaces a weight of air greater than its own weight. Notice its oblong shape in Figure 26.18. Everywhere in its orbital path, gravitational force F pulls it toward the center of the host planet. (a) Show that the average speed of Leslie is 10 km/h when she
runs to the store 5 km away in 30 min. A 16-g sample of methane, CH4, is combined with a 16-g sample of molecular oxygen, O2, in a sealed container. The organic chemicals of living organisms, for example, all contain heteroatoms. An Avogadro's number of grains of sand would fill the United States to a depth of about 2 m. The Proton unit N #
m2/C2 is not central to our interest here; it simply converts the right-hand side of the equation to the unit of force, the newton (N). The rotating skimmer on the settling basin removes buoyant materials and artifacts not captured by the screening process. If the air resistance and overall frictional forces on the car traveling at highway speed are 500
N, show that the distance the car could travel per liter at this speed is 80 km/L. The factors are strength of the atoms (closely packed atoms have more attractive
forces, loosely packed atoms have less attractive forces). In Figure 4.34b, we see several paths of cannonballs fired from Newton's mountain. Temperature A measure of the hotness of substances, related to the average translational kinetic energy per molecule REVIEW 159 in a substance, measured in degrees Celsius, degrees Fahrenheit, or kelvins.
† A downside to CFLs is the trace amounts of mercury sealed in their glass tubing, some 4 mg. Si.. The loose coupling gives the entire train a longer time to gain momentum, requiring less force of the locomotive wheels against the track. He then investigated rocks that are now separated by the Atlantic Ocean. Holding the balloon still would represent
absolute zero! 37. Heat leaks at a faster rate into a cold house. A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 25. So from a clump of ordinary and dark matter, ordinary matter condensed to form a central galaxy. Many pH indicators are found in plants; the pigment of red cabbage is a good example. In today's
spacefaring age, it is more accurate to say, "What goes up may come down," for a critical starting speed exists that permits a projectile to escape Earth. A fuel cell is similar, but runs backward. Grinding and crushing take place as the two plates move past each other. What is the difference between an element and a compound? However, although a
star's brightness is related to its energy output, its brightness also depends on how far away it is from Earth. Bohr was quick to point out that his model was to be interpreted only as a crude beginning, and the picture of electrons whirling about the nucleus like planets about the Sun was not to be taken literally (a warning to which popularizers of
science paid no heed). Ocean currents do not follow the wind pattern exactly, however; they spiral in a circular whirl pattern—a gyre. The vertical component is exactly the same as for an object first melts and becomes a liquid. Basic
Description of a solution in which the hydroxide-ion concentration; also sometimes called alkaline. An 86-proof whiskey, for example, is 43% ethanol by volume. Interestingly, there are already many products on the market that contain components developed through nanotechnology. Chemistry is truly
everywhere. Sirius has a slightly blue color, arly astronomers divided the night sky into groups of stars, called constellations, such as the group of seven stars we now call the Big Dipper. 4 New ton's Law of Cooling 7. ARISTOTLE (384-322 Aristotle was the foremost philosopher, scientist, and educator of his time. Look carefully and see the second
shock wave originating at the tail of the bullet. Twice the charge in the same location has twice the electric potential energy; and so on. Hence you don't topple over. An iron bar can be magnetized easily by aligning it with the magnetic field lines of Earth and striking it lightly
a few times with a hammer. If you've been studying hard, by now you have great insight as to why oil and water don't mix. However, they cannot penetrate unusually dense materials such as lead, which absorbs them. What happens to the volume of a sugar solution as more sugar is dissolved in it? In a similar manner, the Sun's mass curves the
spacetime around it. Dark matter was then discovered to be about six times as abundant as ordinary matter, making up about 23% of the mass needed to halt the expansion. Force Simply stated, a push or a pull. m F m=g 2m 2F = g 2m FIGURE 2.9 INTERACTIVE FIGURE The ratio of weight (F) to mass (m) is the same for all objects in the same
locality; hence, their accelerations are the same in the absence of air resistance. The phosphoric acid salt of caffeine has the structure CH3 N 

H2PO4 N N CH3 O Cl H3CO O N O CH3 N H O H 3C O 57. We get this energy from special highenergy molecules, such as ATP, which the body produces by oxidizing food molecules with oxygen. If you get a
traffic ticket for speeding, is the speed written on your ticket your instantaneous speed or your average speed? What's more fascinating, the dolphin can reproduce the sonic signals that paint the mental image of its surroundings; thus, it is probably able to communicate its experiences to other dolphins by communicating the full The dominant sense
of the dolphin is hearing, because vision is not a very useful sense in the often murky and dark depths of the ocean. Once minerals melt, metamorphism has ended and igneous activity has begun. If you wish to save fuel and you're going to leave your warm house for a half-hour or so on a very cold day, should you turn your thermostat down a few
degrees, turn it off altogether, or let it remain at the room temperature you desire? Distillation involves vaporizing water (Section 16.1). Hewitt 279: (top) Paul G. From Coulomb's law, F = k 2 = (9 * 109 N # m2/C2) d (1.0 * 10-6 C)2 = 10 N. Because of its color and its relative
softness (hardness 3), marble is a popular building stone. In the case of hitting either * This relationship is derived by rearranging Newton's second law to make the time factor more evident. 21, 2019 Type Total Tot
the right contains the greater number of ions, meaning that sodium hydroxide, NaOH, is the stronger base. d 6. If y does not change, an increase in p, and vice versa. Like velocity, momentum is a vector quantity and is therefore directional and capable of being canceled entirely. The range of electronegativities runs from 0.7 to
3.98, as Figure 15.22 shows. (c) nonmathematical thinking. The second major implication of Hubble's observations is that the universe is not contained within a region of space. Sound is the propagation of vibrations through a material medium—a solid, a liquid, or a gas. Cork and gases are buoyed upward like anything else. Note that the water in
contact with the fuel rods is completely contained, and radioactive materials are not involved directly in the generation of electricity. Although its temperature is high, very little thermal energy is conducted to the feet. By convention, the rotational velocity vector and the angular momentum vector have the same direction and lie along the axis of
rotation. * The laws of thermodynamics were the rage back in the 1800s. When the buoyant force equals 1 ton, the iron sinks no further. Atoms are invisible, therefore, because visible light passes right by them. The distance between Earth and the Moon is 3.84 * 108 m. As shown in Figure 27.6, over thousands of years, the intrinsic movement of stars
results in new patterns of stars. (a) F = ma 4 C H A P T E R 4 Gravity, Projectiles, and Satellites 4. One gram of water vapor, the gaseous phase of water vapor vapor
environment. FYI work done time interval The work done in climbing stairs requires more energy than is taken in gets extra energy by "burning" body fat. Tectonic plates Sections into which Earth's crust is broken up; they move
in response to heat flow and convection in Earth's interior. 258 PARTONEPHYSICS Rarefaction A rarefied region, or a region of lessened pressure, of the medium through which a longitudinal wave travels. a radio dish antenna constructed to be a good emitter of radio waves is also, by design, a good receiver (absorber) of them. If the inside
diameter of the cylinder is 12 cm or greater, a person can be lifted by this force. SBR 66. A strike-slip fault "transforms" motion from one ridge segment to another. A piece of metal and an equal mass of wood are both removed from a hot oven at equal temperatures and dropped onto blocks of ice. That is why we begin with physics, then follow with
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chemistry, then investigate Earth science, and conclude with astronomy. First, we get everything into convenient units for calculating: 6.0 \, \mathrm{g} = 0.006 \, \mathrm{kg}; 8.0 \, \mathrm{cm} = 0.08 \, \mathrm{m}. The half brought to rest fall vertically to Earth. The force is perpendicular to both field lines and current. For systems of a given size, more mass usually means lower frequency. FYI
522 PARTTHREEEARTHSCIENCEFIGURE 20.2 Only eight of the chemical elements are found in abundance on Earth. Seeing an apple fall to the ground led him to consider the force of gravity extending to the Moon and beyond. How does a helicopter get its lifting force? If the wall were made of this invisible matter, you would be able to
walk right through it. What do you tell these friends? Stratosphere up to 50 km. CHAP TER 25 the evaporation rate would slow down, but water molecule, H2O,
has a mass of about 18 amu, while a carbon dioxide molecule, CO2, has a mass of about 44 amu. What two planets are evening or morning "stars"? Briefly, how are the concerns of science and religion different? Cathode The electrode where chemicals are reduced. When they reach the right ends of the tracks, which will have the greater speed? As an
air mass moves first upslope and then downslope over a mountain, what happens to the air's temperature and moisture content? Granite, one of the minerals feldspar, quartz, hornblende, and others (Figure 20.16). Objects with everyday temperatures emit
mostly low-frequency infrared waves. Rank the scale readings from greatest to least. Note that the units for mechanical power and electric power agree (work and emits 15 times as much light per watt as an incandescent
bulb. The atmosphere envelops our planet and gives Earth its weather and climate. But if these vibrations were to reach your ear instead, they would be transmitted to a part of your brain, and you would hear sound. Astronauts in a powerful spaceship could enter the fringes of this warp and still escape. A classmate says that the gravitational forces
on everything inside the plane during this maneuver cancel to zero. When you heat the ring, the lines are farther apart—the same amount as if a real gap were there. Both people do the same amount of work because they reach the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there. Both people do the same amount as if a real gap were there are the same amount as if a real gap were there. Both people do the same amount as if a real gap were there are the same amount as if a real gap were there are the same amount as if a real gap were there are the same amount as if a real gap were there are the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the same amount as if a real gap were the s
high melting temperatures crystallize first, because the magma temperature drops below their respective freezing/ melting points. That is, work = KE or, more specifically, W = ©KE. No claim is so outrageous that testimonials can't be found to support it. Base A substance that accepts hydrogen ions. Rays do not converge as with a glass lens, so a
pinhole image is sharp in all positions. Each of these atoms gains an electron and is therefore reduced: Cl2 + 2e- h 2Cl- Reduction The net result is that the two electrons lost by the sodium atoms are transferred to the chlorine atoms. A star's position on the H-R diagram can reveal its age. By midmorning, shown here, the temperature had warmed
sufficiently to allow the alligator to get up and walk away. Unlike conduction, convection occurs only in fluids (liquids and gases). An important credo is "You can never change one thing," Change one thing, and you change another. Because an electron is restricted to discrete orbits, only particular light frequencies are emitted, as atomic spectra
show. According to Einstein, both tossed balls and light curve when close to a planet or star because the spacetime in which they travel is curved (Figure 28.13). (or compressions) in the earphones. Does this mean that the frequency of light emitted by a giant does not depend on its surface temperature as described by Figure 27.9? Were these your
answers? LEARNING OBJECTIVE Use the Hertzsprung-Russell diagram to summarize the stages of stellar development from initial formation to an ultimate fate, such as supernovae. The volcanoes eventually break the surface of the ocean as a series of islands called an island arc. State Archimedes' principle. The H-R diagram shows several distinct
regions of stars. Sunlight is brightest in the yellow-green region, which is in the middle of the visible range. What is the cause of winds on Mars (and also on almost every other planet)? This leads to a layered appearance called foliation. (a) Electrons are able to vibrate at only particular frequencies. 125. G. Is the reaction going on in a rechargeable
battery while it is recharging exothermic? In a neutral solution of supercritical water (374°C, 218 atm) the pH equals about 2. When the Moon assumes its characteristic thin crescent shape, the position of the Sun is (a) almost directly in back of the Moon. Think of homes without electric lights, refrigerators, heating and cooling
systems, telephones, and radio and TV. Alloy A mixture of two or more metallic elements. (c) Each dot in the world's tiniest map consists of a few thousand gold atoms, each atom moved into its proper place by a scanning probe microscope. Foliated Metamorphic Rocks When rock is subjected to increased pressure, some of its minerals realign into
parallel planes as they recrystallize. A force F acts in the forward direction on a cart of mass m. It seemed that catching a worm on a moving Earth would be an impossible task. Does the Milky Way galaxy contain an active galactic nucleus? θ θ A B C 50. Hydrogen is the least polluting of all fuels. (c) rates of thermal expansion. Every age has its groups
of intellectual rebels who are scoffed at, condemned, and sometimes even persecuted at the time but who later seem beneficial and often essential to the elevation of human conditions. The planet Neptune was discovered that very night! Subsequent tracking of the orbits of both Uranus and Neptune led to the discovery of Pluto in 1930 at the Lowell
Observatory in Arizona. Comment on whether or not the following label on a consumer product should be cause for concern. 4 2 A cloud is composed of water droplets of various sizes. Rank the following organic molecules in order of increasing solubility in water: OH O OH N + N H H Cl- H OH (b) (a) 515 REVIEW (b) (a) (c) (c) E X E R C I S E S
(SYNTHESIS) 34. Compare and contrast the Big Bang with a black hole. (f) In 2 s, the change in velocity, from 10 m/s up to 10 m/s down, is 20 m/s (not zero). The appearance of altocumulus clouds on a warm, humid summer morning often indicates thunderstorms by late afternoon. Maxwell's counterpart to Faraday's law A magnetic field is change in
magnetic field induced in any region of space in which an electric field Voltage induced of number of loops * time is changing with time. I think such general propositions can almost always be refuted by well-chosen examples. Ideally, show that the force required to lift the piano is 600 N. People who wash their ziplock bags in hot water (rather than
throwing them away) will note that the ziplock bags are much softer and more flexible in hot water than at room temperature. The polar oxygen-hydrogen covalent bond in each methanol molecule leads to hydrogen bonding between molecules. Piano C Clarinet C The quality of a tone is determined by the presence and relative intensity of the various field to the control of the control 
partials. If instead you rub a glass test tube with silk and bring the rubbed glass near the hanging straw, the two rubbed ends attract. 70. Under conditions of extreme temperature, when can a rock no longer undergo metamorphism? For a coin with only two sides, you'll find that, on average, half the coins will have decayed after one toss. Basaltic
lava erupts where the plates diverge, partially filling the rift between the diverging plates. Show that force F is 25 N if it acts for 2 s to cause a 25-kg cart to gain 2 m/s in speed. If you suspend a bar magnet at its center by a piece of string, you've got a compass. sodium chloride. Scientists call this the "multiverse" model, in which each observable
universe is static, representing one possible arrangement of matter. This is a speed of 8 km/s. In fact, rain or snow may come soon when cirrostratus clouds are followed by middle clouds. Will this temperature likely go up or down over the next billion years? We don't normally witness light being affected by gravity because light moves so fast, but
with careful observations it is quite measurable. In fact, if you want to distinguish whether a hypothesis is scientific, look to see if there is a test for proving it wrong. If you vibrate a Ping-Pong paddle in the midst of the balls, you send a to-and-fro vibration through them. What is induced by the rapid alternation of a magnetic field? Figure 5.43 shows
how to demonstrate this in your kitchen sink or bathtub. The molecules in box A each contain two different types of atoms and so represent a compound. Can something have momentum without having energy? From top to bottom, the mantle's composition is relatively uniform—composed of hot, iron-rich silicate rocks. insolubility, 407 Solutes, 402
soluble, 406 Solutions, 401-405 acidic, 462-465 basic, 462-465 bas
analysis and, 257 frequency of, 247 musical, 255-257 pitch and, 242-243 reflection of, 244 speed of, 243 resonance of, 245 resonance of, 247 musical, 255-257 beats and, 250 bow, 253 Fourier analysis and, 257 interference, 248-251 shock, 253-254 sonic musical, 255-257 pitch and, 245 resonance of, 245 resonance of, 245 resonance of, 246-247 reverberation of, 247 musical, 257 interference, 248-251 shock, 253-254 sonic musical, 257 interference, 248-257 beats and, 257 interference, 248-251 shock, 253-254 sonic musical, 257 interference, 248-257 beats and, 257 interference, 248-257 beats and, 257 interference, 248-251 shock, 253-254 sonic musical, 257 interference, 248-257 beats and, 258 interference, 258 inter
boom and, 254-255 standing, 250-251 Spacetime, 776 Space/time structure, 768-790 Big Bang and, 755, 769-777. All those reddish sunsets would light up the Moon's surface. Here we let F F stand for "total force," FIGURE B.5 FIGURE B.6 VEC TORS 4. (a) 2 AB2 + 2 DCB3 + B2
h 2 DBA4 + 2 CA2 (b) 2 AB2 + 2 CDA3 + B2 h 2 CBA4 + 2 CBA + 2 CBA3 + A2 h 2 DBA4 + 2 CA2 52. 3 2 Ron Hipschman at the Exploratorium removes a freshly frozen piece of ice from the "Water Freezer" exhibit, a vacuum chamber as depicted in Figure 7.31. As the water vapor rises, it can be
channeled into a cooler container, where it condenses into a liquid without the dissolved solids. Because of this difference, alcohols and ethers of similar molecular mass have vastly different physical properties. Why isn't it practical to have a macroscopic sample that is 100% pure? In this sense, the living organism is nature's nanomachine. Are they
still there? If a space vehicle circled Earth at a distance equal to the Earth-Moon distance, how long would it take for it to make a complete orbit? 31. The fronts terminate at the center of what has become a roughly circular area of low pressure (Figure 25.15c). When we look at an object over a hot stove or over a hot pavement, we see a wavy
shimmering effect. In Part 4-Astronomy, the first section of Chapter 28 has been heavily revised. The baking soda will react with the vinegar to form gaseous carbon dioxide. Because of the time delay of the interactions, only its average speed is less than c. These forces depend on friction; a person or car on ice, for example, may not be able to exert
the action force required to produce the needed reaction force. v = fl, (1530 m/s)/(7 Hz) = 219 m. LEARNING OBJECTIVE Describe how ions combine to form ionic compounds. When you remove the nail from the magnet, ordinary thermal motion causes most or all of the domains in the nail to return to a random arrangement. High-temperature
superconductor (HTS) cables, already in use, carry more current at a lower voltage, which means large power transformers can be located farther away from urban centers—allowing the development of green space. The drops act as prisms that disperse light. Drink ice water while chewing gum and note how it quickly hardens. Elements on opposite
sides of the periodic table tend to form ionic bonds. Consumers speak with two voices: their pocket book and the voting booth. Also, heat transfer by convection is minimized because circulating air cannot make contact with the shielded potatoes. (a)
Because this molecule is so small, there is not much opportunity for the gasoline to interact with it through any electrical attractions. As the two plates continue moving apart, mantle rock beneath the new crust in the uppermost asthenosphere cools and hardens. No device has ever been found that can multiply energy! 5.8 Buoyancy in a Gas
EXPLAIN THIS How high will a helium-filled party balloon rise in air? 7 The Quantum Hypothesis 12. Although it can be proven correct by the verification of a single instance of intelligent life existing elsewhere in the universe, there is no way to prove it wrong if no intelligent life is ever found. In short, all living things on Earth contain some carbon
14. Now more than ever, it is important that we "know nukes!" 322 PA R T T W O CH E M I S T RY LEARNING OBJECTIVE Identify three forms of radioactivity and their effects on living tissue. Sufficient work occurs because with each pump of the jack handle, the force she exerts acts over a much greater distance than the car moves. Thus, as we
view this star, we are literally looking at the star as it appeared 4.2 years ago. c, 10. The potassium atom has a hard enough time holding onto its one valence electron, let alone a second one, which is what would happen if the potassium joined in a covalent bond. The fact that you hear an airplane in a direction that differs from where you see it means
the airplane is moving, but not necessarily faster than sound (a sonic boom is evidence of supersonic flight). What change in atomic number occurs when a nucleus emits an alpha particle? Contrary to stories about black holes, they're nonaggressive and don't reach out and swallow objects at a distance. 4 Quantity of Heat 6. As the Moon orbits Earth
we see varying amounts of its sunlit side. These two magma-generating mechanisms produce magma that rises upward through preexisting rock. How far will an object released from rest fall in 1 s? Two things enter the picture whenever work is done: (1) application of a force and (2) the movement of something by that force. What does Jupiter have
in common with the Sun that the terrestrial planets don't? Imagine you're in a completely dark room with no windows and you cut a [email protected] round hole in the roof. With this foundation students are then set to learn the mechanics of chemical reactions and the behavior of organic compounds. (c) A helicopter blade pushes air downward.
Because the electrons are not mobile, energy is transferred much more slowly in insulators. Most facilities tend to favor ozone. (a) about 35% (b) 85% (c) the percentage varies over time (d) over 99% 2. This occurs because each successive wave travels farther to get to A as
a result of the bug's motion. We identify isotopes by their mass number, which is the total number of nucleons in the apple —an external force on the system. It takes only about one-eighth as much energy to
raise the temperature of a gram of iron by the same amount. As more snow falls, the pressure compacts and recrystallizes the bottom layers of icy snow into glacial ice. If you collected 1 million hydrogen—the universe itself is only about 13 billion
years old. The weights of Burl, Paul, and the scaffold produce tensions in the supporting ropes. What is an antinode? Explain how convectional lifting plays a role in the formation of cumulus clouds. The 15th century saw art and science beautifully blended by Leonardo da Vinci. If body A and body B are both within a system, can forces between them
 affect the acceleration of the system? We think of density as the "lightness" or "heaviness" of materials of the same size. (a) Electrons are confined to a small space; therefore they repel one another and remain fairly evenly distributed. The cause of this accelerated expansion has been given the name dark energy. (b) 50°. Does a cyclist coast farther if
the headlamp connected to the bike generator is turned off? Why do we drown when we breathe in water despite all the oxygen atoms present in this material? Test for the presense of oxygen by holding a lighted match with a tweezers and putting the flame near the bubbles. What might you conclude about the curvature of the universe? FYI If we
change the design of the galvanometer slightly so that deflection makes a complete turn rather than a partial rotation, we have an electric motor. And why do hot water heaters lose their efficiency quicker in households with hard water? When uranium fissions into two medium-weight elements, the extra neutrons in their nuclei make them unstable
Pour a small packet of baker's yeast into a tall glass. LEARNING OBJECTIVE Describe how honest inquiry affects the formulation of facts, laws, and theories. The best knowledge filter ever invented for explaining the physical world is science.
twice as much when standing on one foot). Are they nearly equal? In scientific laboratories radioactive samples of all the elements have been made. FIGURE 21.3 INTERACTIVE FIGURE 14.3 The Responsible Care symbol of the American Chemistry
Council; go to responsiblecare.org. If there were once many supermassive stars, they have long since died out. If you point the pinhole camera of the preceding exercise at the Sun, you will see a clear, bright solar image on the viewing screen. (d) Rhodochrosite (whose name means "rose-colored") has a rhombohedral crystal form. Light doesn't exit
the water droplet at angles greater than 42° unless it undergoes two or more reflections inside the drop. The fish appears nearer to the surface and closer than it really is (Figure 11.21). Losing its tungsten, the filament eventually breaks and the bulb "burns out." A remedy is to replace the air inside the bulb with a halogen gas, such as iodine or
bromine. Materials such as glass and water allow light to pass through without absorption, usually in straight lines. The charged particles are subjected to both an electric field and a magnetic field. Recall that sediments are deposited horizontally layer by layer, with the bottom layer deposited first. . Where will the shadow of the airplane appear?
Continental tropical (cT) air polar (mP) Maritime masses are generally responsible for the hot, dry Continental polar (mP) weather of summer, and therefore has a greater tangential speed about the polar axis. Then come back in an
hour or so and you will see that the star has moved away from the landmark but remains in place relative to the other stars. Stepping on red-hot iron coals, however, is a different story. The same may hold true for nanotechnology. How about 2 moles? Planet Earth is indeed a sanctuary for life in an otherwise inhospitable universe. A satellite in
elliptical orbit about Earth travels fastest when it moves (a) close to Earth. Amazing, indeed! 37. He tells you that his radar tracked you moving at a rate of 45 mph away from his parked police car. Most often, when an idea is adopted, particular attention is given to cases that seem to support it, while cases that seem to refute it are distorted, belittled
or ignored. Bohr gave each energy level a principal quantum number n, where n is always some integer. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Amplitude For a wave or vibration, the maximum displacement on either side of the equilibrium (midpoint) position. Does the
following transformation represent a physical change? Copernicus's concept of a Sun-centered solar system was the result of years of studying the motion of the planets. So, any deposit of uranium ore contains some lead that has been converted from uranium. So, strictly speaking, the buoyant force is not 1 kg, but the weight of
1 kg, which is 9.8 N. What event marks the birth of a star? The weight of this much air is about 10 N. (d) 1, 2, 1, 2. 2.5 Summary of Newton's Three Laws 30. Wood, however, will not spontaneously burn even when exposed to pure oxygen, O2. When the dew point is at or below water's freezing point, we have frost.** When a large mass of air cools and
reaches its dew point, we get a cloud near the ground—fog. The reason you can't walk through a wall is because of the repulsions between the electrons in your body and the electrons in the wall (see Section 12.1). 6 Rock Types 20. Some 380,000 years later, particles settled such that the universe became transparent. Beta radiation increases the
atomic number of an element by 1 and does not affect the atomic mass number. As discussed at the beginning of Section 16.3, for example, the volume of dissolved sucrose. (a) none (b) one (c) two (d) three Answers to RAT 1. But none of them pass the
test of being real science. In 2011, an estimated 170 billion liters of bottled water were consumed worldwide, but mostly in developed nations where tap water is potable. If you apply a brief force to a stalled automobile, you produce a change in its momentum. She brings her arm and hand swiftly against the bricks with considerable momentum.
step-up transformer in an electric circuit can step up (a) voltage. In this way, the compressed atoms produce the support force. ** Note the different role of mass here. Look to the Conceptual Physical Science—5th Edition Practice Book supplement for an example. FIGURE 4.22 Without air resistance, speed lost while going up equals speed gained
while coming down: Time going up equals time coming down. Hydrogen bond An unusually strong dipole-dipole attraction occurring between molecules that have a hydrogen atom covalently bonded to a small, highly electronegative atom, usually nitrogen, oxygen, or fluorine. Once the water is boiling, the mug may jostle. A more pleasing example is
given by the sounding boards of stringed instruments. Also note that for larger atoms, not all the electrons in the valence shell are valence electrons. Newton calculated the speed for circular orbit, and because such a cannon-muzzle velocity was clearly impossible, he did not foresee the possibility of humans launching satellites (and he likely didn't
consider multistage rockets). The reactants shown schematically on the left represent methane, CH4, and water, H2O. Strain the broth from the cabbage and allow it to cool. If cooling occurs close to the air's saturation temperature, the condensing moisture can form a cumulus cloud. Physics can indeed enrich your life in more ways than one. E X E F
C I S E S (SYNTHESIS) 48. It is essentially the opposite of a motor. In fact, almost half the mass of Earth's crust is the element oxygen (O) and about a fourth is the element oxygen (Earth's crust is the element oxygen (O) and about a fourth is 
how high is the bridge? So by carefully studying the bending of light from distant galaxies, we can build a map of the dark matter's distribution. Stars with fewer heavier elements formed at an earlier time than the Sun. This is what happens in a nuclear fission bomb (Figure 13.25). What affects one affects the other. The answer is induced dipole-
induced dipole attractions, because the interaction is between two nonpolar entities—the grime and the grime and the nonpolar entities and the grime and the nonpolar entities and the grime and the nonpolar entities and the grime and the gri
combined: Red + blue = magenta Red + green = yellow Blue + green = yellow Blue + green = cyan We say that magenta is the opposite of preen, cyan is the opposite of preen = yellow Blue + green = cyan We say that magenta is the opposite of preen, cyan is the opposite of preen, cyan is the opposite of preen = yellow Blue + green = yellow Blue + gre
technology. C B A T H I N K A N D R A N K (A N A LY S I S) 60. When swimming, have a friend at a distance click two rocks together beneath the surface of water while you are submerged. That's why microwaves pass through foam, paper, or ceramic plates and reflect from metals with no effect. (b) acted on by a force. Relative to the Porsche,
where does the crate crash? Not true! Both the rocket and recoiling cannon accelerate because of the reaction forces exerted by the material they fire—not because of thousands of people and transforming more than 200 mi2 of lush forest into a burned, gray landscape. Just
like the race between a falling coin and feather, the heavier person falls faster and reaches the ground first. In Figure 2.25 we see that this force is provided by an apple, which doesn't change our analysis. Now if you increase your pull to 10 N and your friend pulls oppositely with 5 N, the net force is 5 N in the direction of your pull. Number of =
Number of carbon atoms oxygen molecules 3.00 g F I G U R E 17. Only then is it possible for the atoms in the reactant molecules of the compound and those of the
 element remain intact in the mixture. Milk is a suspension because it is a homogeneous mixture of proteins and fats finely dispersed in water. Why are many craters evident on the surface of the Moon but not on surface of Earth? Even while the battery is not operating, the zinc corrodes as it reacts with ammonium ions. Two pellets, each with a
charge of 1 microcoulomb (10-6 C), are located 3 cm (0.03 m) apart. O. A lone proton encounters the lone pair of electrons of an ammonia molecule and forms what? (d) ac voltage is induced by a changing magnetic field. The moving charges in an electric current do work. 690 PARTHREEEARTHSCIENCE
area is mostly ocean, so most evaporation and precipitation occur over the oceans. Over the course of a night the other stars of the Big Dipper are seen to rotate around this axis, which is diurnal motion. Soap works because soap molecules have both nonpolar and polar properties. As more lanes are added to toll booths, the resistance to vehicles
passing through is reduced. In other words, an electron won't be lost from a sodium C H A P T E R 18 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S atom without the presence of a chlorine atom available to pick up that electron. Bohr used his planetary model to explain why atomic spectra contain only a limited number of light frequencies
Interestingly, bases themselves are not slippery. Try condensing your answer into a single philosophical sentence. According to the generally accepted model, when the two planets first formed they had similar amounts of water. They come from nearly any angle. Surface temperature (K) * One solar mass, 1MSun, is a unit of mass equivalent to that of
 the Sun: 2 * 1033 kg. E xcept for nuclear power, the source of practically all our energy is the Sun. When cumulus clouds turn dark and are accompanied by precipitation, they are referred to as cumulonimbus clouds turn dark and products. (g)
The acceleration of the ball is 10 m/s2 before it reaches its highest point, when it reaches the highest point, when it reaches the highest point, when it reaches the highest point. When the yould be in the air descending from its branch to the ground below, the worm would be swept far away along with the
moving Earth. Why can you drink a cup of boiling-hot tea on top of a high mountain without any danger of burning your mouth? At this point the ant to be an infinite flat plane. 5.1 Density EXPLAIN THIS Does squeezing a loaf of bread increase its mass, its density, or both? The
rock, and minerals formed from the precipitation or evaporation of water make up some types of sedimentary rock. Astronomers have found that the slowing down of time for atoms on our Sun is obscured by their thermal motion. This can be a delightfully tingling experience, depending on the dryness of the air and how pointed your noses are. Focus
your attention on the second word of each term, however, and you'll get it right every time. Show that for 1 kg of pure gold, the volume of water displaced is 51.8 cm3. The electric field about a proton extends radially from the proton. The lines are closer together in
 narrower regions, where the flow speed is greater. Sedimentary rocks originated from weathered material carried by water, wind, or ice. The magnitude of the Coriolis force varies according to the speed of the wind (the faster the aguator). But equator). But equator the flow speed is greater the deflection is greatest at the poles and zero at the equator).
because there are relatively few molecules per spark, the total amount of thermal energy in the sparks is safely small. When we know both the speed and direction of an object, we know its velocity. Electrons move about the nucleus in an atom defining the volume of space that the atom occupies. Which is between the other two? Why don't two
potassium atoms do the same thing? Only a small percentage of the hydrogen needs an energy source; the hydrogen thus produced provides a way of storing and transporting that energy. For example, U-238 decays through several stages to finally become Pb-206
your force and the opposite force of friction affect the motion. Forces are vector quantities. When you lose the sensation, start over moving as slowly or as fast as is comfortable. We can arrange Newton's second law to read Force = mass * acceleration 1 N = (1 kg) * (1 m/s2) We can see that 1 N = 1 kg # m/s 2 The dot between kg and m/s2 means
 that the units are multiplied. This upward force is called the buoyant force and is a consequence of greater pressure at greater depth. Whereas sound is a passive sense for us, it is an active sense for the dolphin, which sends out sounds and then perceives its surroundings by means of the echoes that return. LEARNING OBJECTIVE Distinguish among
the cucumber's cells are losing water to the more concentrated salt water. G ALILEO G ALILE I (156 4 -16 4 2) Galileo was born in Pisa, Italy, in the same year Shakespeare was born and Michelangelo died. There are several methods of weather forecasting. But they race to keep ahead of a growing world population and greater demand in the
developing world. If you expend 10 J of work to push a 1-C charged particle against an electric field, what will be its change of voltage? If the time of impact is not correspondingly increased, a greater force is then exerted on the bricks (and her hand!). 27.3 The Hertzsprung-Russell Diagram 7. (c) 10 m below that line. (d) The caprylic acid reacts to
form the water-soluble salt. Our ability to produce these new and useful materials has been the hallmark of modern chemistry. Both these minerals are found naturally in coal deposits, so their release is a natural consequence of burning coal. (a) Show that the can should be placed a horizontal distance from the base of the table of v12(0.9y)/g. This
lack of attraction between nonpolar molecules explains the low boiling points of many nonpolar substances. All things have energy, and when moving, they have energy of motion—kinetic energy. If an object gains electric fluid, it becomes positively charged with electric fluid. He left Pisa to teach at the University of Padua and became an advocate of
the new theory of the solar system advanced by the Polish astronomer Copernicus. The H-R diagram is to astrophysicists what the periodic table is to chemists—an extremely important tool. Paleo- means "old" or "ancient." As a combining prefix, paleo- is used to describe things that occurred in the past. Even if your pieces were one atom thick, there
would still be two poles on each piece, which suggests that the atoms themselves are magnets. Their velocity changed as they rolled. Because boiling water? Push your right hand away from you (warm air flow) and draw your left hand toward you
(cool air flow). Which law of thermodynamics relates to the direction of heat flow? So the presence of thicker clouds means a higher chance of rain—and a higher chance that a hard rain will fall. (c) v = 60 km/h - 60 km/h = zero km/h. The fact that light waves exhibit polarization demonstrates that light waves are transverse. See Space/ time structure
Tornadoes, 699-700 forecasting of, 701-703 Transform plate boundaries, 572-573 Transformers, 229-230 Transmission of light, selective, 276-277 Transparency, 266-269 Transverse waves, 241-242 Troposphere, 661 Tsunamis, 582-583 Turbulent flow, 604 U Unconformities, in rock record, 623-624 Universal gravitation, 96-97 Universal
gravitational constant, 92-93 Universal law of gravity, 91-93 Universe fate of, 785-787 origin of, 769-777. (b) is perpendicular to the magnetic field. (b) Helium, aluminum, argon. Consider, for example, the combustion of methane, the magnetic field. (b) Helium, aluminum, argon. Consider, for example, the combustion of methane, the magnetic field. (b) Helium, aluminum, argon. Consider, for example, the combustion of methane, the magnetic field.
 Chromium electrode C H A P T E R 18 Battery Cr2+ Hubcap FIGURE 18.35 As electrons flow into the hubcap and give it a negative charge, positively charged chromium ions move from the solution to the hubcap and are reduced to chromium metal, which deposits as a coating on the hubcap. 414: NEPCCO Environmental Systems 415: (top) Saline
 Water Conversion Corporation 415: (bottom) SolAqua 417: (top) iStockphoto 417: (bottom) Pearson Education/Pearson Science 418: City and County of Honolulu 421: Paul G. Then do the same with one equation. (c). 564 PARTHSCIENCE ARTHSCIENCE ARTHSCIE
You also add 5 mL of fresh water to a red balloon, which you also tie shut. If we knew the time during which the impulse occurs, we could calculate the force from the impulse-momentum relationship; however, not knowing the distance or time of the rock's penetration into the ground, we cannot calculate the force. For example, surface rocks that
become deeply buried are subjected to increased pressure. How many electrons are in the third shell of sodium, Na (atomic number 11)? Silk was used to insulate the wires so that current would flow along the wires in the coil rather than across O D D - N U M B E R E D S O LU T I O N S the loops touching one another. A "The rapid progress true
arth's atmosphere is continuously bombarded by cosmic rays, and this bombardment causes many atoms in the upper atmosphere to transmute. If you tried the preceding activity, you will know it is not easy to find yourself amid your many thoughts. Is Earth's magnetism responsible for the spectacular colors of the aurora borealis? This value is time
1300 s 77% of the modern value. Archimedes' Principle 5.4 EXPLAIN THIS How can a concrete barge loaded with iron ore float? A great deal of calcite was formed in this way. For example, heat naturally flows from a higher-temperature object to a lower-temperature object because, in doing so, energy is dispersed from where it is concentrated (a hole
pan) to where it is spread out (the cooler kitchen). F I G U R E 4 .1 5 INTERACTIVE FIGURE Projectiles Launched at an Angle In Figure 4.17, we see the paths of stones thrown at an angle upward (left) and downward (right). When the temperature is high, the constituents of possible minerals are in the liquid state. Because seismic waves weaken
with increasing distance from an earthquake, the strongest ground shaking is generally at the epicenter. Magnetic therapy may likewise be harmless for many ailments, but not when it is used to treat a serious disorder in place of modern medicine. If the fuse is rated at 20 amperes, it passes nected to a household circuit. Why can't you tell whether
you are running a fever by touching your own forehead? Without air resistance, the ball rises just like it falls, covering the same amount of ground while rising as while falling. During an exothermic reaction, energy that was once in the form of the potential energy of chemical bonds is released as the kinetic energy of fast-moving molecules and/or as
electromagnetic radiation. If you were on the Moon and you looked up and saw a new Earth, would it be nighttime or daytime on the Moon? Mass is a measure of the inertia of a mineral, it is not a reliable means of
identification. If it weren't for this dust, the Milky Way would be a much more spectacular nighttime display. Leslie's husband Bob Abrams is shown on page 613. The synthesis of methyl salicylate from salicylic TA B L E 1 9. 358 PA R T T W O CH E M I S T RY CHECKPOINT A compound is uniquely different from the elements from which it is made
How might these particles be separated from the cereal? 109. No matter where a large earthquake occurs, loss of life and devastation result. F L U I D M E CH A N I CS 133 FIGURE 5.33 Pascal's principle at work in the hydraulic devices on this common but incredible machine. If you push the spring down, you can feel the spring pushing up on your
hand. They make up Polaroid filters, popular in sunglasses. CHECKPOINT You draw three dots equally spaced along the length of a rubber band. Wouldn't seeing them float by silently be far more dramatic? Before the time of Galileo and Newton, many scholars thought that a stone dropped from the top of a tall mast on a moving ship would fall
vertically and hit the deck behind the mast by a distance equal to how far the ship had moved forward during the time the stone was falling. Water can also change phase from solid to gas—and from gas to solid—without becoming liquid in between. Resistors heat up when current flows through them, but for small currents the heating is slight. At
each point, the angle of F I G U R E 11 .11 incidence is equal to the angle of reflection (Figure 11.13). In many countries, 50-Hz current is used. You'll see four coins. The amount of air resistance that acts on a wingsuit flyer (and a flying squirrel) depends on the flyer's (a) area. Electrochemistry The study of the relationship between electric energy
and chemical change. Earth, also about the size of a pea, would be about 110 m away, which is greater than the length of a football field. Polarization is a property of transverse waves. When ice changes phase directly to water vapor, the process is called sublimation (Chapter 7). Can you see that it is a lever "in disguise"? One often ignored factor is
soot: black and brown particles emitted by burning fossil fuel—diesel, coal, gasoline, and jet fuel—and from burning solid biofuels—wood, manure, and dung (used for heating homes and cooking in many locations). For convenience, the smaller unit millirem is used, where 1 millirem is used.
of gravity changes only the direction of motion of a satellite in circular motion (and keeps it in a circle), but does not change its speed. The initial thrust of the rocket lifts it vertically. The freezing of water is an example Opacity: transparent Color: colorless of what chemists call a physical change. 168 PARTONE
PHYSICS LEARNING OBJECTIVE Describe the nature of radiant energy. The curved blades cause water to bounce and make a U-turn, which produces a greater impulse to turn the wheel. Why will a bar magnet fall slower and reach terminal velocity in a vertical copper or aluminum tube but not in a cardboard tube? The secondary has 10 turns.
Gravitational force acts on all bodies in proportion to their masses. (The electrical resistance of the instrument is designed to be very low for the ammeter and very high for the current in its windings, the greater its deflection. Now consider the cannon pointing downward. FYI Glass FIGURE 16.31 Fresh water Salt water Black silicone
lining These solar distillers are popular in the remote communities along the Texas-Mexico border, where the waters from the Rio Grande basin are saline and tainted by the runoff of agricultural chemicals from upstream irrigation. She looks at her face in the handheld mirror. Physics problems are typically more complicated than these. The arsenic
is in the underlying rock, which formed from river sediments carried down from the Himalayas. Imagine that you can see individual molecules. With this method, water is put into cavities in deep, dry, hot rock. So, just as the formation and breaking of molecular attractions. When fuel in the underlying rock, which formed from river sediments carried down from the Himalayas. Imagine that you can see individual molecules. With this method, water is put into cavities in deep, dry, hot rock. So, just as the formation and breaking of molecular attractions.
in a rocket burns, a slower explosion, exhaust gases shoot out in one direction. From this example, can you see how temperature differences are a key part of convection? Discuss the illumination in your room compared with that of a 100-W incandescent lightbulb? 2 The Submicroscopic World 14. When traveling through only a few centimeters of air,
alpha particles pick up electrons and become nothing more + + Alpha particle helium nucleus ($2 electric charge) FIGURE 13.2 INTERACTIVE FIGURE In a magnetic field, alpha rays bend one way, beta rays bend the other way, and gamma rays don't bend at all. Each progressive
step toward precipitation is part of the collision-coalescence process. About one-fifth of our annual exposure to radiation comes from nonnatural sources, primarily medical procedures. In general, short-range forecasting predicts weather for the next two days with considerable detail about temperature, wind, and air. What distinguishes an alcohol
from a phenol? It sinks until it reaches a point of equilibrium—the point where it encounters either water of the same density or the seafloor, whichever comes first. When does an adiabatic process happen in the atmosphere? All the drops that disperse the rainbow's light toward you lie in the shape of a cone—a cone of different layers with drops that
 lightbulbs that would not burn out so fast at higher voltages. Which uses more power? This means that the outer-shell electron experiences the nucleus as though it were 1 +, which is significantly less than the actual nuclear charge of 11 +. Compaction is the first step. A second reason is that the matter within a typical galaxy just isn't "clumpy"
enough to allow for the frequent formation of supermassive stars. But "how long" can mean distance also. Which generates comets? Glass is transparent to visible light, but not to ultraviolet and infrared light. Mechanical deformation Metamorphism caused by stress, such as increased pressure. (In practice, the greater current produces a higher
temperature and greater resistance in the lamp filament, so the current is greater than that produced by 110 V but appreciably less than twice as much for 220 V. The nitrogen is oxidized as it reacts with the oxygen while the oxygen is reduced. The new Moon is in the sky in the daytime, not at night. Recall from Section 4.9 that escape speed is the
speed a moving object needs to fly away without ever falling back. Rubbing two materials together transfers "electric fluid" from one material to the other. We have 500 kg silica in original magma - 325 kg olivine 675 kg magma
So, the mass percentage of silica in the remaining magma is 386 kg silica * 100% = 57% 675 kg magma The magma has been enriched in silica. The mass of the same nucleon outside a nucleus is greater than the mass of the same nucleon outside a nucleus is greater than the mass of the same nucleon locked inside a nucleus. Yet not all stars are the same. Most stars are plotted on the band that stretches diagonally
 across the diagram. 80. But if you ever wonder why the model has this or that attribute, the answer can be traced back to the wave nature of electrons. Lead has the atomic symbol Pb after its Latin name, plumbum (Figure 12.6). (The other three are the electromagnetic force and two kinds of nuclear forces.) We sense gravitation only when masses
like that of Earth are involved. Which ball, if either, is in equilibrium? Write a letter to a relative or friend saying that you have discovered the answer to what has been a mystery for centuries—the nature of light. Velocity The speed of an object and specification of its direction of motion. So, on Venus, a day is longer than a year. Upon this collapse,
the force of gravity at the surface increases dramatically. The radiation curve of sunlight divided into three regions—red, green, and blue. Hewitt 231: Paul G. Some organisms produce minerals. In addition to producing about 500 MW of power, the reactor could be the energy source for the creation of hydrogen, H2, which could be used to power fuel
cells, such as those incorporated into automobiles. When this happens, we have a saturated solution, defined as one in which no more solute can be dissolved. CHAPTER 1 TA B L E 1. This cloud builds and grows upward as long as it is fed by an updraft of rising warm air from below. Solute Any component in a solution that is not the solvent. Slate is
the "lowest-grade" foliated metamorphic rock, which means that it was formed under relatively low temperature and pressure. Water is displaced by the stone. The sound intensity varies with different glasses and metal bowls. When white light is refracted twice, as in a prism, the separation of light by colors is quite noticeable. Even after all known
corrections due to possible effects by other planets had been applied, the calculations of physicists and astronomers failed to account for the extra 43 seconds of arc. When astronomers failed to account for the extra 43 seconds of arc. When astronomers failed to account for the extra 43 seconds of arc.
shaped objects: A completely submerged object always displaces a volume of liquid equal to its own volume. At that time, Earth was covered with extensive swamps that, because they were close to sea level, periodically became submerged. In karate, why is a force that is applied for a short time more effective? 1 Obser ving the Night Sky 27. Pure
gold, for example, contains nothing but the element gold. topes. Induced dipole A temporarily uneven distribution of electrons in an otherwise nonpolar atom or molecule. Why are incandescent bulbs typically made of very thin glass? The scale reading increases when the iron block is in the beaker. A vector quantity has both magnitude (how much)
increased height of the mercury column exerts an equal balancing pressure. Between these two cones, the air pressure before sharply to above atmospheric pressure before sharply to above atmospheric pressure. Between these two cones, the air pressure before sharply to above atmospheric pressure.
which are longer than the wavelengths of X-rays. 96. The density of the atmosphere changes gradually, so light rays bend gradually and follow a curved path. (b) decreases. The proton is the nucleus of the hydrogen atom, and it attracts the electron that orbits it. Because the ocean has layers of water that are at different temperatures, the refraction
CHAP TER 25 D R I V I N G F O R CE S O F W E AT H E R 701 FIGURE 25.20 This satellite image of 2005's Hurricane Katrina shows the characteristic appearance of a hurricane. Even if you've never heard the term mole in your life before now, you are already familiar with the basic idea. Nitrogen molecules are not very attracted to one another
 because they are nonpolar. The unit of measurement for work combines a unit of force (N) with a unit of distance (m); the unit of work is the newton-meter (N # m), also called the joule (I), which rhymes with cool. Because of this, sucrose dissolves in water only as long as the number of water molecules far exceeds the number of sucrose molecules
The hang time of a basketball player who jumps a vertical distance of 2 ft (0.6 m) is about 0.6 s. TUTORIAL: Surface Temperature of Planets 25.2 1 kg = 0.03 kg/m3 1000 g Then The volume of 9 kg can be found in this way: 9 kg * * amount of water vapor in air maximum amount of water vapor in air at 30\pm0.03 kg/m3 0.03 kg/m3 * 100% = 60%
Weather Variables EXPLAIN THIS Why does warm air rise and cool air sink? How would you respond in defense of the water's purity, if it indeed does contain thousands of molecules of some impurity per glass? (If the parallel circuit is powered by a stronger source, such as the power provided via common wall sockets, no dimming of bulbs will be
seen as more and more parallel paths are added.) 123. For example, the practice of bloodletting in previous centuries was, in fact, beneficial to a small percentage of men. In shorter form: MOMENTUM AN D ENERGY 71 TUTORIAL: Energy The word work, in common usage, means physical or mental exertion. What benefit accompanies a position of
not knowing answers? Similarly, when you look at the stars, your sense of their beauty is enhanced if you know how stars are born from mere clouds of gas and dust—with a little help from the laws of physics, of course. Neutrons in either piece readily reach a surface and escape before a sizable chain reaction builds up. Tensional stress pulls the crust
apart. As R increases, both Fnet and a decrease, both Fnet and a decrease. The force of gravity is nevertheless acting on you and will be the only force on you until air resistance to express resistance to express resistance builds up. Rearrange the formula current = voltage/resistance to express resistance to express resistance
electric fluid. 75. And all stars, the Sun included, ultimately exhaust their nuclear fuel and die. Give a possible explanation for this. Is it an addition polymer? Electric potential and voltage are the same thing, and they are commonly used interchangeably. Continental convergence occurs when two continental
plates collide. The increase in entropy @S of a thermodynamic system is equal to the amount of heat added to the system @Q divided by the temperature T at which the heat is added: @S = @Q/T. FIGURE C.3 A single grain of wheat placed on the first square of the chessboard is doubled on the second square, this number is doubled on the third, and
so on, presumably for all 64 squares. When steam changes phase to water, it (a) absorbs energy. The most luminous as the Sun. Continental convergence (Figure 21.23c) East Africa may be the site of Earth's
a spectroscope and looking for characteristic patterns. The secondary particles they create are less intense at Earth's surface. They also help us match rocks from different places that are of similar geologic age. A star "dies" when it is no longer able to burn thermonuclear fuel. The mild gale produced a fluctuating force in resonance with the natural
frequency of the bridge, steadily increasing the amplitude until the bridge collapsed. Lighter elements, such as silicon and oxygen, are mostly distributed in the midto-outer portions of the planet. TA B L E 1 5. Burl was heavier than I was, and he guessed the tension in his rope was greater. Are the juices in red cabbage more or less acidic than
 vinegar? Much of today's agriculture is so petroleumdependent that it can be said that modern agriculture is simply the process whereby land is used to convert petroleum into food. C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R 579 FIGURE 21.37 Most earthquakes occur in just a few narrow zones. With eText,
students are also able to pop up definitions and terms to help with vocabulary and the reading of material. Because of the presence of iron and/or magnesium, ferromagnesian silicates tend to be dense and dark in color. The procedure is similar. Atoms give off light as they are subjected to energy. This zinc corrosion can be inhibited by storing the
battery in a refrigerator. Agree, acceleration (slowing the car) is opposite to velocity (the direction the car is moving). These three metals have found great use as currency and jewelry for a number of reasons, including their resistance to corrosion and their remarkable colors. In this chapter we'll learn that when you boil water to make a cup of tea,
the process of boiling tends to cool the water rather than heat it. The king was so pleased with the game that he offered to several thousand volts. Why are people so willing to buy bottled water when it is so expensive, both financially and
environmentally? This "new" magma has a different composition from the partially melted rock that produced it. 18.4 Acidic Rain and Basic Oceans 11. (A solution in water is called an aqueous solution.) An attraction between two polar molecules is called an aqueous solution.
who is reading a book exactly like the one you are reading now. By 1960, fewer than 20 people in the entire United States died from typhoid fever annually. Permanent magnets can be made by placing pieces of iron or similar magnetic materials in a strong magnetic field. And when magna cools to form rock, the new rock, by definition, is igneous
rock, A "New General Catalog" was begun in 1888 that was subsequently used to identify all structures, including the many more that became visible with the advent of more powerful telescopes. Distinguish between condensation and precipitation. A-6 APPENDIX A FIGURE A.9 Force Force Although the magnitudes of the force are the same in each
case, the torques are different. This chain of towering peaks is still being thrust upward as India continues crunching up against Asia (Figure 21.26). Notice how this exceptional photo of the corona also captures some of the pink of the chromosphere as well as the face of the new Moon, which is faintly illuminated by light reflected from the full Earth.
(a) Show that the acceleration is 7.5 m/s2 for a ball that starts from rest and rolls down a ramp and gains a speed of 30 m/s in 4 s. The year 2010 had several extreme weather events—the Moscow heat wave, disastrous flooding in Pakistan, Vietnam, and the South Pacific; drought in the Amazon; and several devastating winter storms throughout the
Northern Hemisphere. (b) If the mass of the egg is 1.0 kg, its speed when it hits the sheet is 2.0 m/s, and it is brought to rest in 0.2 s, show that the average force that acts is 10 N. We will see in Part 2 how polarization plays an important role in chemistry. But for long-wavelength radio waves, it is "polished" and is an excellent reflector. 40 (a)
Temporary dipoles form more readily in larger atoms, such as those in an iodine molecule, because in larger atoms, electrons bunched to one side are still relatively far apart from one another and not so repelled by the electric force. The Mg2 Ion exchange Ca2 Ca Na 2 Na () () Hard water Resin beads Na () 1 Na +
+ Na Na+ Softened water 2 Mg2 Ca2 3 () () () () Mg2 NaNa Na+ () Na 2 () Na Mg () () () Mg2 NaNa Na+ () Na 2 () MIX TURES C H A P T E R 16 calcium and magnesium ions therefore have a greater attraction for the negative sites on the resin. The force that propels a rocket is the reaction to the force the rocket exerts on its exhaust gases. Part of the
energy reaching Earth falls on plants (and on other photosynthetic organisms), and part of this, in turn, is later stored in the form of coal. In 1915 he published his hypothesis of continental drift, which eventually led to the discipline of plate tectonics. If it bounces from your head, you may be in more serious trouble. Its domain is therefore restricted
to the observable natural world. Place a concentrated dot of ink at the center of the piece of porous paper. That's why there is a net attraction. A similar enzyme is found in baker's yeast. At the end of 3 days, one-eighth of the original sample remains. No, because 14 amu is less than the mass of a single oxygen atom. Like me, Burl had never studied
physics in high school. 6.4 Quantity of Heat 12. We say that the bus accelerates. At 30;; C (86;; F), some nonmetals are solid (carbon, C), others are liquid (bromine, Br), and still others are gaseous (helium, He). 45. The greatest change in atomic number? If a single disturbance sends longitudinal waves at one known S-12 O D D - N U M B E R E D S O
LUTIONS speed and transverse waves at a lesser-known speed, and you measure the difference in the arrival times of the waves, you can calculate the distance. The centers of the circular waves move in the direction of the swimming bug. The motion of molecules that most affects temperature is (a) translational motion. Aspirin is useful for adults,
but for young children it can cause a potentially lethal condition known as Reye's syndrome. Both heat and electric conductors are characterized by electric charges that are free to move. Submerge the skewer or weight in the sugar syrup.
more slowly than the temperature of sand. As an air mass is pushed upward over a mountain range, the rising air expands and cools; if it is humid, clouds form. So it is common to refer to infrared radiation. Then, once above the drag of the atmosphere, it is aimed horizontally, whereupon the payload is given a final thrust to orbital
speed. Think about what happens to the volume of an air-filled balloon on top of water and beneath. Rem A unit for measuring the ability of radiation to harm living tissue. When vertically falling sand lands in a horizontally moving cart, the cart slows. Only when there is no force at all, or when two or more forces combine to zero, can an object be in
equilibrium. You don't cancel a force on the car with a force exerted on you. When the jumper is running, the liftoff force during jumping can be somewhat increased by the pounding against the ground (and the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat increased by the pounding of the feet against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be somewhat against the ground force during jumping can be so
standing jump. The sideways component, S, F I G U R E B .1 0 is called drag. Then make your jump, and, at the point you are able to reach, make another mark. From greatest to least, rank the (a) net forces on the boxes and (b) accelerations of the boxes. REVIEW 143 104. The net result is an even distribution of O C O bonding electrons around the
entire molecule. It covers many possibilities. Laminar flow Water flowing smoothly and fairly slowly in straight lines with no mixing of sediment. Ma 102 in seq ue 10 nc e 1 Sun 0.1 10-2 White dwarfs 10-3 10-4 Increasing temperature (Kelvin) typically the size of Earth or even smaller, yet they have mass
comparable to the Sun. The total mass of an atom is called its atomic mass. 742 PARTFOUR ASTRONOMYFIGURE 27. Except for a bit of reflection, the ink absorbs all the visible frequencies and therefore appears black. Show that the formula mass of 2-propanol, C3H8O, is 60 amu, that the formula mass of propene, C3H6, is 42 amu, and that
the formula mass of water, H2O, is 18 amu. Force is up VIDEO: Magnetic Forces on a Current-Carrying Wire F I G U R E 9 .1 7 Force is down nt re Cur INTERACTIVE FIGURE A current-carrying wire experiences a force in a magnetic field. These are periodic tones, or musical "notes." (But musical instruments can make noise as well!) Such graphs
can be displayed on the screen of an oscilloscope when the electrical signal from a microphone is fed into the input terminal of this useful device. When heated, the greater expansion of the brass bends the strip. Can you see that the presence of air resistance reduces net force? Reading Check Questions (Comprehension) These questions frame the
important ideas of each section in the chapter. So KE = total energy - PE = 9500 MJ - 6000 MJ = 3500 MJ - 6000 MJ - 6000 MJ = 3500 MJ - 6000 MJ - 
second. Paul's dear personal friends include Burl Grey on page 21, who stimulated Paul's love of physics a half century ago, and Will Maynez, showing the airtrack he built for CCSF on page 70 and burning a peanut on page 160. Data are encoded in binary code, with zeros and ones distinguished by the frequency of domain reversals. The frequency
and period are the inverse of each other: Frequency = 1 period Or, vice versa, Period = 1 frequency CHECKPOINT 1. But if the spaceship is accelerating, the floor overtakes the ball and it hits the wall below a point opposite the window (Figure 28.11). The equations of science provide compact expressions of relationships between concepts. (a) A, B,
C, D. How is the composition of the "whole Earth" different from that of "Earth's crust"? The quantities are only half as much, but their ratio is the same as when 11 g of carbon dioxide is formed: 1.5:4:5.5 = 3:8:11. What are the mass percentages of the oxides MgO, FeO, and SiO2 in pyroxene, MgFeSi2O6? By how much does the power
decrease? FIGURE 3.3 The force of impact on a golf ball varies throughout the duration of impact. Amazingly, your brain fills in the "expected" view even with one eye closed. Radioactive source Paper Aluminum Lead CHECKPOINT Pretend you are given three radioactive rocks—one an alpha emitter, one a beta emitter, and one a gamma emitter
What would be the surface area density of stars? (a) Grass grows. What is the relationship between a planetary nebula and a white dwarf? For very slow-moving bullets, the dropping distance is comparable to the horizontal range, and the resulting parabola is easily noticed (the curved path of a bullet tossed sideways by hand, for example). Kinetic
Energy If you push on an object, you can set it in motion. Hewitt iStockphoto International Atomic Energy Agency Steve Cole/Getty Images, Inc.- Photodisc./Royalty Free P-2 PHOTO CREDIT S 325: (top) iStockphoto 325: (bottom) Jerry Nulk and Sra Joshua Baker 326: Iris Christiani/Bionerd via Flickr 329: (a, b) Saint-Gobain Crystals & Detectors 331:
Lawrence Berkeley National Laboratory 337: iStockphoto 342: ITER 344: John Suchocki/Paul G. EXPLAIN THIS VIDEO: Light and Transparent Materials ibrating electrons emit most electromagnetic waves. As it turns out, less complex found to precede their more complex counterparts and starlight is found to bend as it passes close to
the Sun, which support the claims. In these and most other cases of covalent-bond formation, the result is a filled valence shell for all the atoms involved. Figure 14.8 shows three examples. Satellites in close circular orbit fall about 5 m during each second of orbit. So the half-life is not a function of how many atoms you have. Which of the following is
not accepted evidence for the Big Bang? Then show that this is equivalent to about 4200 kJ. Such a system, however, would have its costs. To pull bonded atoms apart requires an energy input. In the last few minutes, stars and planets will become unbound. Infrared waves, which have frequencies lower than those of visible light, vibrate not only the
electrons but the entire molecules in the structure of the glass and in many other materials. Someone standing at the edge of a cliff (as in Figure 1.24) throws a ball straight up at a certain speed and 107. This star-sized diamond is about 4000 km wide, which amounts to about 10 billion trillion tr
popular stories tell us. There is the story of the engineer who explained to gold? Do we have magma because Earth's
interior is molten? This relationship is called Archimedes' principle. Residents of some valley towns in the Rocky Mountains, such as Salida, Colorado, benefit from this adiabatic compression and enjoy "banana belt" weather in midwinter. What is the concentration of hydronium ions in a solution that has a pH of -3? The classic example is what
happens upon the formation of a black hole—spacetime contracts to a point of zero volume (and infinite density). (a) Crystalline structure form of halite Crystal Form FIGURE 20.5 The structural form of the mineral halite (table salt) is cubic. (Does force change when you interchange m1 and m2 in the equation for gravity—m2m1 instead of m1m2?)
102. As each kernel is heated, the water within each kernel is also heated to the point that it would turn into water vapor. So the heat radiated by you and your classmates increases the temperature of the room. Its diameter, not counting its ring system, is nearly 10 times that of Earth, and its mass is nearly 100 times Earth's. A starburst tends to die
down once the disturbance is removed or after the starburst galaxy consumes all its interstellar fuel. How does the weight of mercury in a barometer tube compare with the weigh
soluble solids increases with temperature, while the solubility of others is only very slightly affected by temperature. 9 Bow Waves and the Sonic Boom 10. Why does the sky normally appear blue? In 1930 at age 50, however, his luck ran out. The molecules of an automobile's exhaust, for example, cannot spontaneously recombine to form more highly
organized gasoline molecules. In both cases, a greater mass (greater inertia) is balanced by a correspondingly greater gravitational force, so the acceleration remains the same (a = F/m, Newton's second law). As water in a confined pipe speeds up, the pressure it exerts against the inner walls of the pipe (a) increases. In a neutral solution [H30s]
[OH \ge] In an acidic solution [H30 \le] \neg [OH \ge] In a basic solution [H30 \le] \neg [OH \ge] In a basic solution [H30 \le] \neg [OH \ge] The outer surface of hair is made of microscopic scale-like structures called cuticles that, like window shutters, can open and close. In this way, carbon-free electricity is produced. For substances in thermal contact, thermal energy flows from the higher temperature
substance into the lower-temperature substance until thermal equilibrium is reached. For example, 3 g of carbon would have the same number of particles as 8 g of molecular oxygen. Whatever you may have learned in your early schooling, Pluto is no longer a planet. Both
have great impact on society. Like hydronium ions, they play a part in many acid-base reactions. e, 8. If the mass of the [email protected] object is greater than 1.2 kg (so that its weight is greater than 1.2 kg (so that its weight is greater than 1.2 kg (so that its weight and mass
are proportional to each other. A mirage is not, as many people think, a trick of the mind. SAM PLE PROBLEM 2 Show that 44 g of carbon dioxide, CO2, is produced when 16 g of methane, Conversion factor CH4, reacts with oxygen, O2. When the Sun rises, the star will have already set and is obscured by the ground. 50 coins? Hewitt 427: Getty
Images 432: (left, middle, right) Pearson Education/Pearson Educat
a big advantage, but it should be regarded as a storage and transport medium for energy, not as a fuel. Briefly, what is science? (Caution: We are talking about velocity? Thunderclouds are seen below the aurorae, and the
nearest major moon, Io, is seen at center left. The liquid freezes when its molecules vibrate about fixed positions and form a solid. This force of gravity was the current in each is quite different. Through this reaction, is sulfur oxidized or reduced?
That's why fire engines and tennis balls are yellow-green for better visibility. 25.5 Violent Weather 29. Which pulls harder: the Moon on Earth or the Moon? After multiple attempts, he is unsuccessful. We'll do some sample calculations in a moment. Materials that are poor conductors are called insulators. Explain the connection between
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photosynthetic life on Earth and the ozone layer. Does the scale read 0 N, 100 N, or 200 N, or does it give some other reading? FIGURE 16.27 Slaked lime, Ca(OH)2, and aluminum sulfate, Al2(SO4)3, react to form aluminum hydroxide, Al(OH)3, react to form aluminum hydroxide, Al2(SO4)3, react t

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magma is generated by the partial melting of rising mantle rock. The computer draws maps of projected weather conditions, which the weather forecaster uses as a guide for predicting weather. A power of 100 kW (105 W) is delivered to the other side of a city by a pair of power lines, between which the voltage is 12,000 V. As the main stream
channel becomes choked with sediment, it takes more energy for water to push through the accumulated sediment than to go around it. As shown in Table 19.5, addition and condensation polymers have a wide variety of uses. REVIEW 27 C H A P T E R 2 7 Stars and Galaxies O n a moonless night the unaided 27. At other angles, the force is less, and
it becomes zero when the particle moves parallel to the field lines. Superconducting coils produce a strong and rigid structure, which is used to align the protons of hydrogen atoms in the body of the patient. This network of carbon atoms forms a very strong and rigid structure, which is
why diamonds are so hard. Also, the infrastructure for distributing hydrogen would need to be built. In the winter Vermonters make a tasty treat called "sugar on snow" in which they pour boiled-down maple syrup onto a scoop of clean fresh snow. First, an electron has more potential energy when it is farther from the nucleus. Therefore, more
current exists in the circuit, which is sometimes a problem. So the Big Bang marked not only the beginning of space. I n 1915, Einstein published his now famous general theory of relativity, which was a huge reworking of Newton's well-tested laws of gravity. Thus, the "liquid" has become depleted in red and enriched in
black—its composition n FYI 20.5 O Cr rde ys r o ta f lli za tio 530 CHAPTER 20 R O CK S A N D M I N E R A L S 531 has changed. The planetary nebula, however, will disperse within a million years, leaving the Sun's cooling carbon core behind as a white dwarf. They are important because they play a leading role in determining the chemical
properties of the atom. One such model suggests that if the observable universe were the size of a proton, they form a scum, which can appear as a ring around the inside of your bathtub. A generator normally produces ac. In a nonbonding pair, both electrons
originate in the same atom; in a bonding pair, one electron comes from one of the atoms participating in the covalent bond. This skill involves creative energy and, like other electron comes from the other atom participating in the covalent bond. This skill involves creative energy and, like other skills, improves with experience. Electric power The rate of energy transfer, or the rate of doing
work; the amount of energy per unit time, which can be measured by the product of current and voltage: Power = current * voltage It is measured in watts (or kilowatts), where 1 A * 1 V = 1 W. Water at 100°C will boil when the heat needed for a phase change is added. The hydrogen bomb is another example of a discovery used for destructive rather
than constructive purposes. Most of our environment is seen by diffuse reflection. 94 PARTONEPHYSICS FIGURE 4.5 4 units of distance 1 unit of distance 2 units of distance 2 units of distance 3 units of dist
considerably more than the escape speed from Earth. 128 PARTONEPHYSICS sample of gas at some initial time is equal to any different volume of the same sample of gas at some initial time is equal to any different pressure * different volume of the same sample of gas at some later time. Interestingly, insulation doesn't prevent the flow of thermal energy. (b) Cinder cones, such as Sunset Crater in Arizona, generally
have smooth steep slopes of 25° to 40° and bowl-shaped summit craters. A transformer works by way of (a) Coulomb's law. This graphic, however, shows dark matter's distribution over a narrow region of the sky back to about 6.5 billion years ago. The low energy required to rotate the Falkirk Wheel is due to balanced caissons, which weigh the same ago.
as long as the water in them has the same depth. What color would sunsets be? Astrology is a belief system that began more than 2000 years ago in Babylonia. Why doesn't the rope break when he is supported as shown on the left? Low-silicacontent minerals have high melting points. Time 9.8 Power Production EXPLAIN THIS Two hundred years
ago, people got light from whale oil. Pole reversals and paleomagnetism provide strong evidence for seafloor spreading. To reemphasize this often confused concept: when we talk about the expansion of the universe, we are referring to an expansion of the very structure of space itself. Firing a gun with blanks at close range is a definite no-no because
of the considerable momentum of ejecting gases. In general, the shorter the half-life of a substance, the faster it disintegrates, and the more radioactivity per amount is detected. amide 5. Remarkably, photos revealed a landscape similar to Earth's despite the fact that the materials are completely different (Figure 26.19). This plane, called the ecliptic
is defined as the plane of Earth's orbit. What is the difference between a compound and a mixture? If you store your extra flashlight batteries in the refrigerator, they'll last longer. Sound and light waves, on the other hand, travel in three-dimensional space in all directions like an expanding balloon. The approach of a warm front, although less obvious
and more gradual than the approach of a cold front, is also indicated by cirrus clouds. Consider a 6.0-g steel nail 8.0 cm long and a hammer that exerts an average force of 600 N on the nail when it is being driven into a piece of wood. Which force is greater? Characteristic patterns are an increase in crystal size due to recrystallization and changes in
the water content of the metamorphosed rock. So connect a pair of resistors in parallel for less resistance. But take a look around you. Conceptual Fifth Edition Paul G. How many oxygen atoms are bonded to the carbon of the ca
space around a single star in units of AU (Note: 1 light-year = 63,000 AU.) 39. What are the outward forces that act on a star? Disappointed, but recognizing that brute fact must always win over a beautiful hypothesis, he placed his papers in a drawer, where they remained for nearly 20 years. What is an H-R diagram? Stages of resonance. FYI we
eat? The consensus among scientists is that Earth's climate is warming too fast. When current flows Your two ears are so sensitive to the differences in sound reaching from rest at one end of a runway accelerates uniformly at 4.0 m/s2 for 15
s before takeoff. They regarded the surface of the planet as a static skin spread over a molten, gradually cooling interior. Show that her speed at the bottom of the slide is 280 m/s, or 8.9 m/s, Aluminum, a metal, is an element in pure form (sold commercially as a mixture of mostly aluminum with trace metals, such as magnesium). Otherwise, the
shadows are not aligned, as shown in the lower drawing. The heat you felt was caused by radiation, which travels at the speed of light. Whenever the force of air resistance also occurs, the falling object is not in free fall. The direction of force is not along the magnetic field lines or along the direction of current. (Note: 0.22 lb = 1 N; 1 kg on Earth's
surface has a weight of 10 N.) 39. As you will see shortly, however, organic molecules may contain more than one type of functional group. G L O S S A RY Metamorphic rocks formed from preexisting rocks that have been changed or transformed by high temperature, high pressure, or both. Chilling a battery, therefore, slows down the rate at
which the zinc corrodes, which increases the life of the battery. F I G U R E 1 2 .1 0 Geoplanetary models suggest that hydrogen exists as a liquid metal deep beneath the surfaces of Jupiter (shown here) and Saturn. You are who you are, but your behavior changes depending on whom you are with. A relatively close AGN is found within the large
elliptical galaxy M87, which was shown in Figure 27.25. Rather, water molecules are so attracted to themselves because of their polarity that they pull themselves together. The temperature (which measures the average kinetic energy of the molecules) decreases and the water is cooled. Electric current has a single pathway through the circuit. In
general, chemical sedimentary rocks form where there are no clastic sediments. If external presalong the freshwater face of the sure is applied to the salt water, even more water molecules are squeezed across the membrane than along the solumembrane from the salt water, even more water molecules are squeezed across the membrane than along the solumembrane from the salt water, even more water molecules are squeezed across the membrane than along the solumembrane from the salt water into the fresh water, even more water molecules are squeezed across the membrane from the salt water into the fresh water, even more water molecules are squeezed across the membrane from the salt water into the fresh water, even more water molecules are squeezed across the membrane from the salt water into the fresh water, even more water molecules are squeezed across the membrane from the salt water into the fresh water, even more water molecules are squeezed across the membrane from the salt water into the fresh water, even more water molecules are squeezed across the membrane from the salt water into the fresh water into the fresh water into the fresh water molecules are squeezed across the membrane from the salt water into the fresh water into the fresh water molecules are squeezed across the fresh water into the fresh water molecules are squeezed across the fresh water molecules are squeezed across
the amount of time it takes for half of the original quantity of a radioactive element to decay. (a) The landing speed is 60 km/h - 40 km/h = 20 km/h. How many days does sunlight take to travel the 50,000 AU from the Sun to the outer reaches of the Oort cloud? Warm, dry air holds more water vapor than cold, dry air. Although earthquakes associated
with normal faults are quite common, the most catastrophic earthquakes occur along reverse faults, usually those at subduction zones. Surface area density = (1.00 * 1011 stars)/(7.85 * 109 [email protected])2 = 12.7 stars/[email protected] 39. (b) Water is pumped into the hole at high pressure and fractures the surrounding rock to form a cavity with
increased surface area. CHECKPOINT Is it correct to say that a radio wave is a low-frequency light wave? What does this indicate about the shielding typically surrounding the two types of power plants? Hewitt (top right) Dartmouth Electron Microscope Facility (bottom a, b, c) John Suchocki/Paul G. They do energize, however, water molecules. Bond
energy The amount of energy required to pull two bonded atoms apart, which is the same as the amount of energy released when the two atoms are brought together into a bond. (This method of increasing torque sometimes results in shearing off the bolt!) 2. Chemicals in the paste receive electrons at the graphite stick and so are reduced. Neither!
The frequency of a wave undergoes a change when the source is moving, not the wave speed. A small percentage, however, have one neutron, and a smaller percentage have two neutrons. Though this process is costly, the positive effects of these adjustments have been demonstrated. m 20 kg 20 kg Fnet 2(30,000 N) 43. Addition polymer A polymer
formed by the joining together of monomer units with no atoms being lost as the polymer forms. With an applied voltage of 120 V, the current in the bulb is I = V/R = (120 \text{ V})/(95 \text{ W}) = 1.26 \text{ A}. When a source of waves travels as fast as the waves it produced. As with phenols, the acidity of a carboxylic acid results in part
from the ability of the functional group to accommodate the negative charge of the ion that forms after the hydrogen ion has been donated. eu Power source eu Al product Cathode eu Reduction AlF63u S E S O F CH EM I C A L R E AC T I O N S aluminum metal, and, by 1890, the price of
aluminum had dropped to about $2 per pound. nuclear forces dominate. Some of the world's most famous faults, such as the San Andreas Fault in California, are strike-slip faults. The cosmic background radiation is radiation that came from the universe when it was only about 380,000 years old. Strain begins at depth as elastic deformation. At first,
waves and particles may appear contradictory. Metamorphic reactions can also occur without the involvement of fluids. FYI Several things have to happen for precipitation to form. Precipitation of rain or snow is not usually produced by stratocumulus clouds. At high elevations there is less atmosphere above to filter out ultraviolet rays, so climbers
are exposed to more high-energy radiation. would inevitably lead to a moment when all the galaxies were gathered together, perhaps within a single point. What is the difference between being immersed and being submerged? In chemical batteries, this work may be done by the chemical disintegration of zinc or lead in acid, and the energy stored in
the chemical bonds is converted to electric potential energy. (d) all of these Answers to RAT 1. A, B, D, C. Size affects bond strength as well, because small atoms and ions can generally pack closer together than large atoms and ions. If a magma contains molten forms of quartz and olivine (a silicate mineral), which crystallizes first as the magma
cools? 7.9 Energy and Change of Phase 29. The volume of a sugar solution gradually increases as more sugar is dissolved in it. Old lithosphere is simultaneously destroyed in deep ocean trenches near the edges of continents. R oses are red and violets are blue; colors intrigue artists and physical science types too. The pull-push force creates vibrations
(waves) in the Slinky. And we know that air pressure goes down when air The temperature of a parcel of expands. It can still be seen, preserved at the library of the Royal Society in London with the inscription: "The first reflecting telescope, invented by Sir Isaac Newton, and made with his own hands." It wasn't until Newton was 42 that he began to
write what is generally acknowledged as the greatest scientific book ever written, the Philosophiae Naturalis Principia Mathematica. The frequency of the alternating voltage that is induced is equal to the frequency of the alternating voltage that is induced is equal to the frequency of the changing magnetic field within the loop. At convergent boundaries, andesitic magma dominates. Groundwater Underground water
in the saturated zone. or its affiliates. Just as Earth spins counterclockwise, the Moon revolves around us counterclockwise, though not as fast as we spin. When you pull, however, part of the pulling force is directed upward, which helps to lift the wheel over the step. Earth's surface is heated unequally, with some areas heating up more quickly than
others. This might be proven wrong if starlight that grazed the Sun and could be seen during a solar eclipse were undeflected from its normal path. The middle shadow is cast by the green spotlight and is not dark because it is illuminated by the red and blue lights, which produces magenta. In a high-pressure region, air sinks and warms adiabatically
About an electron, the field is in the opposite direction (Figure 8.9). A fire walker walking barefoot across hot wooden coals depends on wood's (a) good conduction. Here we see \boxtimes F = 0 again! Then acceleration becomes zero. If and when a hypothesis or scientific claim is confirmed, it is regarded as useful and as a stepping-stone to additional
knowledge. Later in the same century, geology was accepted, but theories of evolution were condemned and the teaching of them was forbidden. Noble gases are not considered in electronegativity discussions because, as previously mentioned, they rarely participate in chemical bonding. Give a reason why canal enthusiasts in Scotland appreciate them.
physics illustrated in Figure 5.16 (the block of wood floating in a vessel brim-filled with water). 2 F R E E - FA L L V E L O C I T Y AC Q U I R E D A N D D I S TA N C E FA L L E N Time of Fall (s) Velocity Acquired (m/s) Distance Fallen (m) 0 1 2 3 4 5 0 10 20 30 40 50 0 5 20 45 80 125 * When we divide km h by s 1 kmh, s 2, we can express the result
as km h * 1 s = km h#s (some textbooks express this as km/h/s). Consider what happens when hydrogen ion, H + , does not readily exist in water because any hydrogen ion formed is quickly picked up by a water molecule and transformed to the hydronium ion, H3O + . Two hundred years ago, young boys
called powder monkeys ran barefooted below the decks of warships to bring sacks of black gunpowder to the cannons above. Today's hybrid cars do the same and divert braking energy to electrical storage batteries, where it is used to complement the energy produced by gasoline combustion (Chapter 9 treats how they accomplish this). Mesosphere
The third atmospheric layer above Earth's surface, extending from the top of the stratosphere to 80 km. Defining Your System FIGURE 2.24 INTERACTIVE FIGURE 4 force acts on the orange system and it accelerates to the right. 5 The Formation of Minerals 20. These lithospheric plates ride atop the relatively plastic asthenosphere below. Recall, for
example, that in neutral water the hydroniumion concentration is 0.0000001 M (10-7 M). Surface wave A type of seismic wave that travels along Earth's surface. Power = CHAPTER 8 S TAT I C A N D CU R R E N T E L E C T R I CI T Y 207 FIGURING PHYSICAL SCIENCE Problem Solving SAM PLE PROBLEM 1 If a 120-V line to a socket is limited to
15 A by a safety fuse, will it operate a 1200-W hair dryer? Summer and winter constallations are different because (a) of the spin of Earth about its polar axis. "She moves at a constant direction." Say the same sentence in fewer words. CHAP TER 26 THE SOL AR SYSTEM 725 FIGURE 26.27 The Moon spins about its own polar axis.
just as often as it circles Earth. A stationary front is Cold air L Cool air B A Warm air Cold air Cool air B A Warm air Cold air Cool air B A Warm air Cold air Cool air B Warm front Cool air B A Warm air Cold air Cool air B Warm front Cool air B Warm front Cool air B Warm air Cold air Cool air B Warm front Cool air B Warm front Cool air B Warm air Cold air Cool air B Warm front Cool air B Warm air Cold air Cool air B Warm front Cool ai
an occluded front for the case when a cold front overtakes a warm front. 46. The wind gains speed as it flows over the roof, as the crowding of streamlines in Figure 5.39 indicates. Push on a brick and it accelerates (see Figure 2.7). They are the last minerals to melt and the first minerals to crystallize. Note that the steeper the incline, the greater the
component S becomes and the faster the object rolls. Snow-making machines used at ski areas blow a mixture of compressed air and water through a nozzle. (Metabolism is really "burning" at a slow rate.) A common heat unit for labeling food is the kilocalorie (kcal), which is 1000 calories (cal), the heat needed to change the temperature of 1 kg of
water by 1°C. This arrangement is called a generator. Hess's hypothesis of seafloor spreading provided the mechanism to explain continental drift. The acid-base reactions forming these salts are shown in Table 18.1. The reaction between an acid and a base is called a neutralization reaction. Thus, in air at a normal room temperature of about 20°C,
sound travels at about 340 m/s. The neutron bounces with practically no loss of energy and practically no change of speed (like a marble bouncing from a bowling ball). Tesla's genera- Steam tors had armatures consisting of bundles of copper wires that were made to spin within strong magnetic fields by means of a turbine, which, in turn, was spun
by the energy of steam or falling water. The horse refuses, saying that to try would be futile, for it would flout Newton's third law. (Answer begins with an N.) 30 PA R T O N E P H Y S I CS (The acceleration of free fall is further developed in Appendix A and in the Conceptual Physical Science Practice Book.) We see that the distance of free fall from
rest is directly proportional to the square of that time of fall. FYI FIGURE 21.36 Fault line underground The actual underground The actual underground location where fault rupture occurs is the focus. When a material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small to measure, so all we can tell is that the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than about 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than 50,000 years, the amount of carbon-14 that is left in it is too small the material is older than 50,000 years, the amount of carbon-14 that is left in it is l
years. So planetary gravitation cannot be an underlying agent for astrology. Instead, their presence is only implied, so that the focus can remain on the skeletal structure that is formed by the carbon atoms. GmM/(d + 200 \text{ km})2 49. (b) the
density of materials. The crust of the ocean basins is compact—it's about 10 km thick and composed of dense basaltic rocks. The wall adjacent to the rocket thrusters would push up against any occupants and become the floor, while the opposite wall would become the rocket thrusters would push up against any occupants and become the floor, while the opposite wall would become the ceiling. Although you may be at rest relative to Earth's surface, you're moving
about 100,000 km/h relative to the Sun. Apparent brightness is the brightness of a star as it appears to our eyes. Frequency = 1/period = 1/(3 s) = 13 Hz. 4 1 . 2 2 Cassiopeia M 31 Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed that the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the Andromeda Pegasus Rigel Hubble showed the great spiral nebula within the great spiral nebula within the Andromeda Rigel Rig
stars, which is now called the Andromeda galaxy and catalogued as M31. The downside is the enormous complexity of successful and safe operation. A boat propelled to the east by its motor experiences water friction to the west. The melting of these ice crystals further decreases the volume of the water. Light incident on a dry surface, such as sand,
bounces directly to your eye. If they are closely situated, Photon sphere F I G U R E 2 7. Chemists therefore need to know the relationship between the mass of a given sample and the number of atoms or molecules contained in that mass. Scholarly activity ceased in most of Europe through the Dark Ages, and the works of Aristotle were forgotten and
lost in the scholarship that continued in the Byzantine and Islamic empires. A 10-kg iron ball is dropped onto a pavement from a height of 100 m. Both of these damage sites contained structures built on unconsolidated sediment. Transfer of heat by the motion of fluid as it rises or sinks is called convection. In the case of the crumpled drum in the
preceding question, the surrounding air has more pressure than whatever air remains inside the barrel. See also Acid(s); Bases hydronium ions in, 455-459 protons in, 456 hydroxide ions in, 457 neutralization, 458-459 protons in, 457 neutralization, 458-459 protons in, 458-459 protons in a second in the se
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stability, 688-689 Atom(s), 294-320 attractive forces between. The density of a rock doesn't change when it is submerged in water. The quantity force * time interval is called impulse. Hewitt 278: (top) Paul G. When pieces of calcite and fluorite are scraped together, which scratches which? Is it important that the metals expand at different rates? If
you rub an inflated balloon against your hair and place it against a door, by what mechanism does the balloon stick? A heteroatom is any atom other than carbon or hydrogen in an organic molecule. But how does rock melt to become magma? If you focus first on the concepts, the vocabulary will come to you much more naturally. No; the propagation
of energy travels, not the medium itself. What is the test for whether or not a hypothesis is scientific? If this bulb is connected to 220 V, it would carry twice as much current * twice the voltage), more than 600 W. Hewitt 447: (bottom) Julie Cupit/Paul G. See Ocean waves period of, 239.
240 rarefaction and, 242 shock, 253-254 sound, 239, 242-257. The particles in arkose tend to be angular and not as well sorted as those in quartz sandstone. Go online and look up the total synthesis of the anticancer drug Taxol. To solve the problems below, you will need to know the average coefficient of linear expansion, a, which differs for
different materials. (a) Pratt Guyot 0 10 20 km 2 4 km (b) Volcanic rocks (such as basalt) form at Earth's surface where they cool quickly; they tend to have microscopic crystals. Hewitt 480: (top left) John Suchocki/ Paul G. (That's a flow of 6.25 billion billion electrons per second.) In a wire that carries 4 amperes to a car headlight bulb, for example, 4
C of charge flows past any cross-section in the wire each second. As a result, air is warmed over the land and rises. The resulting field is greatest for iron atoms. What defines a material as being a mixture? How would it be affected if Earth instead shrunk? This form of unknown energy is generally described as dark energy (Figure 28.20). A simpler
method was later developed by Philipp von Jolly, who attached a spherical flask of mercury to one arm of a sensitive balance (Figure 4.4). An advantage that molecular computing has over conventional computing is that it can run a massive number of calculations in parallel (at the same time). Nonferromagnesian silicates do not contain significant
amounts of iron or magnesium, so they have lower densities and a lighter color. Biological growth, therefore, is best described as a chemical change. Bare feet scuffed the decks much less than 8.2 shoes and ensured no charge accumulation that might produce an igniting spark and an explosion. On a hot day you can see ripples in the air as hot airon that might produce an igniting spark and an explosion. On a hot day you can see ripples in the air as hot airon that might produce an igniting spark and an explosion. On a hot day you can see ripples in the air as hot airon that might produce an igniting spark and an explosion.
rises from an asphalt road. Adding more mass means stronger gravitational forces that compress the volume. FIGURE 10.26 The interference of two sound sources of slightly different frequencies produces beats. Such breaking and forming of chemical bonds involve changes in energy. What is the chemical formula for the compound dihydrogen
sulfide? Instead, the convergence is more like a head-on collision (see Figure 21.23c). As previously mentioned, a quantity such as velocity that specifies direction as well as magnitude is called a vector quantity. The more the rock is compressed, the more rigid and elastic it becomes. If our skin is moist, 24 V can be quite uncomfortable. We can learn
about emotions such as rage and love, even if we haven't yet experienced them. Because of its great mass, it would be a most spectacular and potentially dangerous tail for those viewing from Earth. After being caught and turned northward by the cyclonic flow, the dry conveyor belt also becomes incorporated into the upper-level westerlies. So how
do positively charged protons in the nucleus stay clumped together? (a) How many kilograms of silica are in 225 kg of pyroxene? 10 kg water B C D 61. Which has a greater momentum: an automobile at rest or a moving skateboard? (c) energy. Nitrate ions, NO3-, from the salt bridge flow into the left container to balance the positive charges of the
Fe2 + ions that form, thereby preventing any buildup of positive charge. The voltage drop across each device is proportional to its resistance. Alteration is greatest at the contact area, and it decreases farther away from the contact area, and it decreases farther away from the contact area. Why
and they both form hydrogen bonds. Rhyolite forms when granitic lava erupts at Earth's surface. Now we see why this is so—horizontal and vertical components of motion are independent of each other. According to the shell model, electrons behave as though they are arranged in a series of concentric shells. Heavier atoms are produced in stars
which are massive collections of hydrogen atoms pulled together by gravitational forces. Further, a viable theory of solar system formation must explain other known features of the solar system and look for the effect. If you stand equally on
each scale, each will read half your weight. The carbon-hydrogen structures are nonpolar. There's confusion about what can and can't be recycled. A block of iron will displace its weight and still be partially above the mercury's surface. Torque More torque Force Even more torque 90° Lever arm 90° Lever arm which the force acts. We can
see this in two ways. How many known planets are in our solar system? Your friend says that one way to improve air quality in a city is to have traffic lights synchronized so that motorists can travel long distances at constant speed. No energy can be removed from a system at 0 K. It turns out that a charge of 1 C is the charge associated with 6.25
is a net emitter and cools; if it's colder than its surroundings, it is a net absorber and becomes warmer. Continued compacting increases the temperature of this layer, which appears in the nighttime sky as a new star (nova is Latin for "new"). Might this appears in the monuclear blast that we see as a nova, which appears in the might this appears in the might thin appear appear appear appear appear appear appears in the might thin appear appea
be a solution to the problem of global warming? How much tension is there in a vertical rope that holds a 20-N bag of apples at rest? Yes; the difference is that the rotation in a motor continues, whereas in a galvanometer the deflection is momentary. A tossed rock, a cannonball, or any object that is projected by some means and continues in motion
by its own inertia is called a projectile. Were these your answers? The resistance of a typical lamp cord is much less than 1 \( \), and a typical lightbulb has a resistance of more than 100 \( \). The pitch of the sound gets lower as the glass is filled. Barrier islands form where ridges of sand break the surface of the water and allow vegetation to take hold. The
horse concludes that it can't exert a greater force on the wagon than the wagon exerts on itself and, therefore, the horse wouldn't be able to accelerate the wagon. High-resolution images of this galaxy. After the front passes, the air cools and sinks,
pressure rises, and rain ceases. (a) Show that the average force of egg impact is mv/t. The two forces on the bag are equal in magnitude and opposite in direction, and they cancel to zero. As more atoms bond to the microscopic crystal, repeating the underlying pattern, the crystal grows. If your metal car moves over a wide, closed loop of
wire embedded in a road surface, is Earth's magnetic field within the loop altered? If the original clump was spinning a bit faster, then the new stars would be spinning fast enough to flatten the galaxy, much like a rapidly spinning ball of pizza dough. (See Figure 27.38 from the preceding chapter.) A third success of cosmic inflation has to do with them.
very shape of the universe. When the pH of a solution is 1, the concentration of hydronium ions is 10-1 M = 0.1 M. When the fulcrum of a lever is relatively close to the load, a small input force produces a large output force. Hydrocarbons that have low boiling points, such as gasoline, travel to the cooler regions at the top of the tower before
condensing. Add another capful of isopropyl alcohol to the stirred yolk and observe what happens. Spark plug Piston Fuel/air intake Compression Power stroke Was this your answer? Relative dating The ordering of rocks in sequence by their comparative ages. What is a crystal? (c) A hydroxide ion is a water molecule minus a hydrogen nucleus. How
much sodium chloride, in grams, is needed to make 15 L of a solution that has a concentration of 3.0 g of sodium chloride per liter of solution? In 1962, he was awarded the Nobel Peace Prize for his campaign against the testing of nuclear bombs, which introduced massive amounts of radioactivity into the environment. (a) One, TiO2 is a mixture of
and O2. Using this concept of entropy, you are now in a position to understand why exothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on their own without need of external help—while most endothermic reactions are self-sustaining—occurring on the self-sustaining are self-sustaining.
LECTRICITY 201 EFFECTOFELECTRICCURRE NTSONTHEBODY Current Effect 0.001 A 0.005 A 0.010 A 0.015 A 0.015
receive no shock at all. The buoyant force acts upward because pressure is greater against the bottom where the water is deeper. How will the apparent brightness of these stars compare if Star A is twice as far away as Star B? What will be its average speed? The pattern of frequencies formed by a given element—some of which are shown in Figure
12.23—is referred to as that element's atomic spectrum. How do the electron-dot structures of elements in the same group in the periodic table compare with one another? Three times the distance is 1/9 the intensity and 1/9 the reading. Denser materials settle to the bottom, and less-dense materials migrate to the top. Similarly, some forms of
induced dipole attraction 426 PARTTWOCHEMISTRYREADINESSASSURANCETEST(RAT) If you have a good handle on this RAT. The rising air cools, and if the air is humid, clouds form and precipitation occurs. VIDEO: Refraction of Sound 246 PART
O N E P H Y S I CS DOLPHINS AND ACOUSTICAL IMAGING "see" a thin outline of the body—but the bones, teeth, and gas-filled cavities are clearly apparent. And on Earth, far inland away from bodies of water, weather conditions such as Chinook winds and tornadoes occur. CHAPTER 2 2.3 Forces and Interactions 17. If you rotate your arm in a full
circle while keeping the same angle, what shape does your arm describe? In the language of organic chemistry, we say that the configuration of a molecule, such as pentane, has a broad range of conformations. Consider the electrical attractions. Pyrite has replaced the original shell in this specimen. Deimos is about half the size of Phobos, and it
orbits Mars in 30.3 hours at a distance of 20,000 km from the Martian surface. Pelton patented his idea, and he probably made more money from his invention, the Pelton wheel, than any of the gold miners earned. The reaction forces account for our motion in these cases. Earth scientists have found evidence that Earth's poles periodically reverse
places—more than 20 reversals have occurred in the past 5 million years. This is peculiar because you may first think that the Big Bang occurred within an already existing infinite space and that matter and energy flew outward from this Big Bang to occurred within an already existing infinite space and that matter and energy flew outward from this big Bang to occurred within an already existing infinite space and that matter and energy flew outward from this big Bang to occurred within an already existing infinite space and that matter and energy flew outward from this big Bang to occurred within an already existing infinite space and that matter and energy flew outward from this big Bang to occurred within an already existing infinite space and that matter and energy flew outward from this big Bang to occurred within an already existing infinite space and that matter and energy flew outward from this big Bang to occurred within an already existing infinite space.
information can tree rings from these huge redwoods tell us about climate? Use the inverse-square law to show that in space-shuttle territory, 200 km above Earth's surface, the force of gravity on a shuttle is about 94% that at Earth's surface. FIGURE 3.27 The three main engines of a space shuttle can develop 33,000 MW of power when fuel is
burned at the enormous rate of 3400 kg/s. Also, effluent from freshwater activities, such as personal hygiene and dishwashing, is treated and reused for watering city trees and other nonpotable uses. So, whether an object moves or not, it has some form of energy. Such a study using the Hubble Space Telescope is illustrated in Figure 28.18. Make
small hole near the bottom of an open tin can. I you drop a stone into a calm pond, waves travel outward in expanding circles. In the liquid phase, they vibrate about fixed Diamond Water positions. Set A, therefore, represents only a physical change. That is, the vector sum of the liquid phase, they vibrate about fixed Diamond Water positions. Set A, therefore, represents only a physical change. That is, the vector sum of the liquid phase, they vibrate about fixed Diamond Water positions. Set A, therefore, represents only a physical change. That is, the vector sum of the liquid phase, they vibrate about fixed Diamond Water positions.
= 0. Global-scale cooling leading to continental-scale glaciers is most likely caused by the right combination of three things: the arrangement of continents around the globe, the amount of sunlight reflected back into space, and the geometry of Earth's rotation on its axis and revolution around the Sun. Step 1: Fill a cooking pot to a depth of about 1
cm. (b) Many forests downwind from heavily industrialized areas, such as in the northeastern United States and in Europe, have been noticeably hard-hit by acid rain. (You won't be able to do this in your bathtub unless it's 10.3 m deep!) 140 PA R T O N E P H Y S I CS 35. 5 CH E M I S T RY CONTINUED Polymers Repeating Unit Common Uses
Recycling Code Condensation Polyethylene terephthalate O O C C 1 Clothing, plastic bottles O CH2CH2 PET O O H N Melamine-formaldehyde resin (Melmac, Formica) N C C N N N H C Dishes, countertops Not recycled C HN C O Addition Polymers Addition polymers form simply by the joining of monomer units. The resulting vibrating air sets your
eardrum into vibration, which, in turn, sends cascades of rhythmic electrical impulses along nerves in the cochlea of your inner ear and into the brain. He maintained his membership in the Royal Society and was elected president, then re-elected each year for the rest of his life. Is dark matter found mostly within or just outside a galaxy? Dissolve as
much sugar as possible in some boiling water, then allow the solution to cool. The heavier isotopes have the effect of slightly raising the average. If electrons were positive and protons were negative, would Coulomb's law be written the same or differently? The melting point increases because of a greater number of induced dipole-induced dipole
molecular attractions between adjacent hydrocarbon molecules. This famous photo was taken by Apollo 17 astronauts as they returned from the last manned mission to the Moon in 1972. FIGURE 20.35 Common foliated metamorphic rocks: (a) slate, (b) schist, and (c) gneiss. A strong electric current passed through the molten aluminum oxide-
cryolite mixture generates aluminum metal at the cathode, where aluminum ions pick up electrons and are thus reduced to elemental aluminum. For example, the Ethiopian rift zone spread by about 8 m in 2006! At the same time, 2.5 km3 of magma intruded into the crust (enough to fill 2000 football stadiums)! Earth in action! 190 million years,
seafloor spreading has transformed a tiny waterway through Africa, Europe, and the Americas into the vast Atlantic Ocean of today! Spreading centers are not restricted to the ocean floors but also develop on land. Note that the trend repeats from one horizontal row to the next. As investigators attempt to reach this lowest temperature, it becomes
more difficult to get closer to it. As a result, the inner and outer planets developed differently. What physical test could you use to determine whether this mineral is a diamond? Rocks, after all, are made of minerals. Thus, when a dry air parcel at ground level at a comfortable 25°C rises 6 km, its temperature drops to a frigid - 35°C! On the other
hand, if air at 6 km elevation, at a typical temperature of - 20°C, descends to the ground, its temperature rises to a whopping 40°C! Adiabatic processes are not restricted to dry air. Show that his estimation of wave speed is 3 m/s by (a) the classic formula for speed, distance divided by time, and (b) frequency * wavelength. Why doesn't the repulsive
electric force of protons in the atomic nucleus cause the protons to fly apart? The wider the gap in time, the greater the distance—which could be in any direction. What does it multiply? Hard water Containing large amounts of calcium and magnesium ions. Instead of two containers, a voltaic cell can be an all-in-one, self-contained unit, in which
case it is called a battery. Both have strong effective nuclear charges and are strong oxidizing agents. Some fossils are made of whole organisms, but most fossils are just parts of an organism. So, apologize to the police officer and pay for the speeding ticket. (This is about 190 miles per gallon [mpg].) The important point here is that, even with a
hypothetically perfect engine, there is an upper limit of fuel economy dictated by the conservation of energy. As you may expect, active subduction zones are areas of intense earthquakes. 177 Pressure of atmosphere plus water F I G U R E 7. For example, these elements are weak conductors of electricity, which makes them useful as semiconductors of electricity.
in the integrated circuits of computers. The water vapor condenses. The charges in sodium chloride are balanced, but they are not neutralized. The Andes continue to grow higher due to the ongoing subduction of the oceanic Nazca Plate beneath the South American Plate. Why can't batteries do the same? In fact, a rocket operates better above the
atmosphere where there is no air resistance. Hot bluish stars are toward the left side of the diagram and cool reddish stars are toward the right side. Streak is the color of a mineral in its powdered form. It is often advantageous to position highly reflective surfaces behind the stage to direct sound out to the audience. Ozone, O3, can be toxic, and it
has a pungent smell commonly associated with electric motors. If it moves steadily at constant speed, with no change in its motion, it is in equilibrium. Rank from greatest to least the volume of water at these temperatures: (a) 0°C, (b) 4°C, and (c) 10°C. The ball with the initial projection angle of 30°, however, is in the air for a shorter time and hits
the ground first. There's much that we can't see. If no net force or net impulse acts on a system, the momentum of that system cannot change. Then do the same with a copper pipe. For water, 18 g is 1 mole. energy Water In combustion, electrons are transferred when polar covalent bonds are formed in place of nonpolar covalent bonds, or vice versa
The aluminum behaves as a reducing agent as it gives electrons back to the silver (Al S Al3+ + 3 e-). Fluorine is one of the smallest atoms, and nonpolar molecules made with fluorine atoms exhibit only very weak induced dipole-induced dipole attractions. Once alpha and beta particles slow down, they combine to form harmless helium. FYI VIDEO:
Discovery of Neptune In both cases, you'd experience weightlessness. What weight of water is displaced by a 100-ton floating ship? See Phase changes Solubility, 406-409 of minerals, 532 temperature and, 407-408 vs. In cases A, B, and C, the crate is in equilibrium (no acceleration). Both remove thermal energy from one place and
put it in another by the phase change of a refrigerant. Does it follow that 1.5 g of carbon will react with 4 g of oxygen to form 5.5 g of carbon dioxide? Then in the early 1920s, the astronomer Edwin Hubble, using the new Mt. Wilson telescope, discovered that the Andromeda "nebula" was, in fact, a separate galaxy farther away than the outermost
stars of the Milky Way. (c) bounced. The larger one, not yet common, uses less than 8 W and replaces a samesize incandescent 60-W bulb. The induced voltage in a coil is proportional to the rule f 2 T, the book therefore emits radiation
whose peak frequency f is quite low compared with the radiation frequencies emitted by the other substances. The founder of modern chemistry. The familiar facial features of the "man in the Moon" are always turned toward us on Earth. The forces between the apple and Earth are the same in the Moon" are always turned toward us on Earth.
magnitude. 6 Mass- Energy Equivalence 13. The grouping of stars into constellations tells us about the thinking of astronomers of earlier times, but it tells us nothing about the stars themselves. If you don't have the opportunity to work with a spectroscope in your laboratory, check out the activities at the end of this chapter. We do this by taking
advantage of the differences in physical properties of water and the solutes or particulates it contains. Eruptions from a volcano are more familiar to us because they are very dramatic to see, but the outpourings of lava from fissures are much more common. When a pair of charged particles are brought twice as close to each other, the force between
them becomes (a) twice as strong. Solution: You should know that 100,000 is the same as 105. 546 PARTHREEEARTHSCIENCETypes of Metamorphism: Contact metamorphism is the result of rising molten magma
that intrudes a rock body. 8.10 Electric Power 30. Cloud droplets grow larger and heavier within the cloud until they eventually begin to fall as rain. These three stars are too close together and too far away (about 430 light-years) to be distinguished with the naked eye. The red supergiant, Antares, for example, is so large that, if drawn to scale, it
would reach the ceiling of your classroom. That way, it doesn't appreciably lower the current it measures. A moment later, when the forks are out of step, a compression from one fork meets a rarefaction from the other, resulting in a minimum. Science is an ongoing human activity that represents the collective efforts, findings, and wisdom of the
human race, an activity that is dedicated to gathering knowledge about the world and organizing and condensing it into testable laws and theories. 8.6 Electric Current EXPLAIN THIS What kinds of current are produced by a battery and by a generator? Consider seriously the following question. As discussed in Section 18.4, we are placing unusually
large amounts of carbon dioxide into the atmosphere by burning fossil fuels. Which has the greatest number of atoms? Density The ratio of the mass of a substance to its volume. So please give extra care to the study of this material. Hold this charged balloon up close to, but not touching, a thin stream of water running from a faucet. The atomic mass
of an element as presented in the periodic table is actually the average atomic mass of its various isotopes. Consider the two polymers polyethylene terephthalate (PETE) and polystyrene (PS). Show that 70 J of work is done when a 20-N force moves a cart 3.5 m from its initial position. CHAPTER 2 appreciably greater than 170 km/h (100 mph)
Furthermore, it builds a strong foundation for understanding how atoms form chemical bonds, which is the main focus of Chapter 15. Further, they showed that the temperature of about 3 K. If the north pole of one magnet is brought near the north pole of another magnet
they repel. What is the source of energy that keeps the dunking bird in Figure 7.26 operating? FIGURE 26.40 The Barringer Crater in Arizona, made 25,000 years ago by an iron meteorite with a diameter of about 50 m. The electrons in the outermost shell, therefore, are quite important. These magnets are strong enough to hold sheets of paper
against a refrigerator door, but they have a very short range because the north and south poles cancel a short distance from the magnet. Hawaii friend Chiu Man Wu is on page 174 and with daughter Andrea on pages 87 and 267. Electricity and magnetism connect to form (a) mass. When dark energy gains full rein, the result may be an infinite
vacuum—an empty hole. (Does a faster ball take a longer time to hit the floor?) Defend your answer. Therefore very little thermal energy is transferred to the feet. This process absorbs energy rather than releasing it. Whereas a force produces an acceleration, inertia is a resistance to acceleration. The metal, in turn, cools the water within. The
chirps have a higher frequency due to the Doppler effect. 1.2 Galileo's Concept of Inertia 3. If the star collapses to onetenth its radius, gravitation at its surface increases a hundredfold. Q = mLf = (200 g)(80 cal/g) = 16,000 cal. 300 cal(4.19 J/1 cal) = 1257 J. A very dilute solution of a strong acid or a strong base may have little corrosive (a) The pure
water in this circuit cannot conduct electricity because it contains practically no ions. Remember that a chemical change (also known as a chemical reaction) involves molecules breaking apart so that the atoms are free to form new bonds with new partners. 466 PA R T T W O CH E M I S T RY FIGURING PHYSICAL SCIENCE Logarithms and pH The
logarithm of a number can be found on any scientific calculator by keying in the number and pressing the [log] button. Even if the wire is a few thousand volts above ground potential and you hang by it with two hands, no appreciable charge flows from one hand to the other. Why is ice slippery? Principle of equivalence Local observations made in an
accelerated frame of reference cannot be distinguished from observations made in a Newtonian gravitational field. Just like wearing a black shirt on a sunny day, soot in the atmosphere absorbs solar radiation—heating the surrounding air. A quick way to figure this out is to count up the number of carbon atoms in beta-carotene, which is forty, and
divide by five. This is a scenario common with many physics students: you push a heavy car by hand. In this way, a radioactive equilibrium is reached at which there is a constant ratio of about one carbon-14 atom to every 100 billion carbon-12 atoms. So the speed equals 45 mm/s. Venus is frequently the first starlike object to appear after the Sun
sets, so it is often called the evening "star," as illustrated in Figure 26.9. Compared with other planets, Venus most closely resembles Earth in size, density, and distance from the Sun. The number of hours of sunlight (and solar energy) depends on the incidence of the Sun's rays on Earth's surface. How does the force of friction between the desk and
floor compare with your push? It has taken about 190 million years for a mere fracture in an ancient continent to turn into the Atlantic Ocean. (Ouch!) 47. So the force of friction is 550 N in the opposite direction. If there is no test for its possible wrongness, then the hypothesis is not scientific. This momentum is quickly reduced when she delivers an
impulse to the bricks. What happens to the uranium-235 nucleus when it is stretched out? How do fronts cause clouds and precipitation? Is a biological cell macroscopic, microscopic, micro
passes through the leaves, which overlap to create image-forming pinholes. Water is a weak acid. Energy absorbed by any substance increases the jiggling motion of molecules, which raises the temperature. The carbon dioxide cycle requires water. Melded to the fresh crust above, new lithosphere is formed, which slowly moves away from the
spreading center, cools, contracts, and becomes denser. Why don't you hear the sound of a distant fireworks display until after you see it? Might enough matter exist within the universe to halt or even reverse this expansion? Two or more different metals can be bonded to each other by metallic bonds. O O 59. In a similar manner, the electrons
responsible for the negative charge of the phenoxide ion can migrate around the ring, as shown in Figure 19.12. In the time it takes sound to go from A to B. Radium-226 is created by the radioactive decay of uranium, which persists for billions of years. (d) Rayleigh surface waves have a rolling, up-and-down motion, similar
to ocean waves. Which cart will accelerate more, and how much greater will the acceleration be? So number of secondary turns as secondary turns. Because of the tip, eclipses occur only when the Moon intersects the Earth-Sun plane at the time of a threebody alignment
(Figure 26.37). The air in your house is an example of a (a) homogeneous mixture because it is mixed very well. Why is this question an exercise in careful reading as well as in physics? (c) half as strong. 9.7 Generators and Alternating Current EXPLAIN THIS Why does a generator produce ac rather than dc? Look at Figure 15.34 to see how hydrogen
bonding works. So, when floating chunks of ice in the Great Lakes melt, the water evaporates; the salts are left behind, thus making the seawater saltier. The more massive the ball, the more it warps the two-dimensional surface. The circular motion is
clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. Stainless steel, for example, is a mixture of the elements can decay backward or forward in the periodic table. P late tectonics describes the motions of Earth's lithosphere that create
ocean basins, mountain ranges, earthquake belts, and other large-scale features of Earth's surface. Most of the energy released is Although a mere match can ignite a thermonuclear bomb. Satellites do, 8k in fact, crash to Earth's surface from time
to time 5 m m when they encounter air resistance in the upper atmosphere that decreases their orbital speed. Determine the atomic mass of chlorine, Cl (atomic number 17), if 75.53% of all chlorine atoms are the chlorine-35 isotope. Matter has mass and occupies space. Whales should be glad that humans are the chlorine-36 isotope and 24.47% are the chlorine-37 isotope.
equilibrium with system C, then A and B are in thermal equilibrium with each other. The empty space trapped above, except for some mercury vapor, is a pure vacuum. These large molecules are still too small to be seen with the unaided eye. Human thought is evolving toward more order. The Sun was born about 4.5 billion years ago at position 1
when the fusion of hydrogen ignited. \theta A \theta A \theta B \theta C 290 PA R T O N E P H Y S I CS E X E R C I S E S (SYNTHESIS) 53. EXPLAIN THIS E vidence now suggests that the Big Bang generated matter in at least two different forms—one we can see and another that we can't. Just because an acid or base is strong doesn't mean a solution of that acid or
base is corrosive. Why does recrystallization occur in metamorphic rock? Suppose that, at a restaurant, you are served coffee before you are ready to drink it. (b) Both are still occurring. Show that the force of gravity between Earth (mass = 6.0 * 1024 \text{ kg}) and the Moon (mass = 7.4 * 1022 \text{ kg}) is 2.0 * 1020 \text{ N}. Often these target molecules are organic
compounds that have been isolated from nature, where they can be found in only small quantities. Would more or less of this product form if the pot contained ice water? LEARNING OBJECTIVE Describe the meaning of the lowest possible temperature in nature. But what is light? Neutralize this base by adding an acid, but not just any acid—use the
484 PA R T T W O CH E M I S T RY acid of your breath. (This "latitude effect" provided the first evidence that cosmic rays from outer space consist of charged particles—mostly protons, as we now know.) 67. The tight alignment of neighboring strands makes H Ethylene monomers H C C H FIGURE 19.26 The addition polymer polyethylene is formed
as electrons from the double bonds of ethylene monomer molecules split away and become unpaired valence electrons. Gold consists of only gold atoms, a flask of gaseous nitrogen atoms, and the carbon of a graphite pencil consists of only gold atoms, a flask of gaseous nitrogen atoms. We will see later that electromagnetic waves, some of which are radio
waves and light waves, are also transverse waves. Does 1 kg of water or 1 kg of iron undergo a greater change in temperature when heat is applied? 4 0 In clean air, the scattering of highfrequency light gives us a blue sky. CHAPTER 5 6. 88. Free fall Motion under the influence of gravitational pull only. So if we speak of doubling energy consumption
in the next however many years, bear in mind that this means in these. VIDEO: Circular Orbits FIGURE 4.29 (a) The force of gravity on the bowling ball is at 90° to its direction of motion, so it has no component of force to pull it forward or backward, and the ball rolls at constant speed. Not at all! It consists of the same number of atoms no matter
what the location. S-waves are transverse; they vibrate the particles of their medium up and down and side to side, they are not as fast (register second on a seismograph), and they can travel through solids only. F I G U R E 5 .11 A liter of water occupies a volume of 1000 cm3, has a mass of 1 kg, and weighs 9.8 N. The temperature of the corona is
amazingly high—on the order of 1 million K—and it is where most of the Sun's powerful X-rays are generated. A quantity known as weight density, commonly used when discussing liquid pressure, is expressed by the amount of weight density, commonly used when discussing liquid pressure, is expressed by the amount of weight density, commonly used when discussing liquid pressure, is expressed by the amount of weight density.
Hydrogen Oxygen CHECKPOINT 1.29 1.25 1.21 0.178 0.090 1.43 The metals lithium, sodium, FYI and potassium (not in Table 5.1) are all less dense than water and float in water and float in water. 15.2 The Formation of Ions EXPLAIN THIS Too much detail to learn? How soon might we know the answer? At what part of an elliptical orbit does an Earth satellite have
the highest speed? atoms. A nurse counts 72 heartbeats in 1 min. Colors appear quite different in sunlight. A more recent bridge disaster was caused by wind-generated resonance (Figure 10.18). Note that pressure does not depend on the volume of liquid. But rising through the thicker continental crust takes longer, allowing more time for
crystallization and silica enrichment. What is the difference between the minerals that make up a rock and the minerals we find in common dietary supplements? Remind your friends that physics is about finding the connections in nature! P L U G A N D C H U G (FORMULAFAMILIA RIZATION) F g G m1m2 d 2 36. When English is
imparted by striking the cue ball off-center, rotational momentum, which is also conserved, somewhat complicates analysis. The gas used in balloons prevents the atmosphere from collapsing them. FYI LEARNING OBJECTIVE Describe friction and its direction when an object slides. In solid carbon dioxide (dry ice), molecules jump directly from the
solid to the gaseous phase—that's why it's called dry ice. The rules of projectile motion apply to jumping. If the current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 4 A in one of the branches, how much current is 10 A in the main wire and 10 A in th
Could the gravitational pull on the apple reach to the Moon? What happens to the ball? You will need a calculator with a logarithm function to answer this question. In the past 20 years, the average life expectancy in most nations has risen by a couple of years. Why is gas compressible while liquid is not? Both protons and neutrons are called nucleons,
a generic term that denotes their location in the atomic nucleus. S-waves cannot move through fluids—they travel only through solids. When a bow is drawn, energy is stored in the bow. An electron travels around 2 million m/s. The next closest planet, Venus, would be the size of a pea about 80 m (255 ft) distant. How are the
particles in a solid arranged differently from those in a liquid? When the lenses overlap at right angles, light doesn't get through. The bird sees the worm and drops vertically from a tree onto a horizontally moving skateboard.
The greater pressure in the troughs pushes water into the even higher crests. Hewitt (a, b, c, d) Princeton University, Palmer Physical Laboratory (bottom) Paul G. In summary, three major lines of evidence strongly support the Big Bang theory. The number of possible structural isomers for a chemical formula increases rapidly as the number of
carbon atoms increases. Be clear about the distinction between frequency and speed up again when emerging onto the smooth surface. Here we can see its pattern (a) 100,000 years ago; (b) as it appears at present; and (c) as it will appear in the future,
about 100,000 years from now. The collapsing effect dominates until the temperature reaches 4°C. A substance consisting of which molecule shown below should have a higher boiling point? When you blow your horn while driving toward a stationary listener, he hears an increase in the frequency of the horn. Note: Distances are not to scale in this
illustration. Hydrogen, with one proton per atom, has atomic number 1; helium, with two protons per atom, has atomic number 2; and so on. CHECKPOINT If you push a magnet into a coil, as shown in Figure 9.25, you'll feel a resistance to your push. That oxygen gas is formed can be demonstrated by inserting a glowing wood splint into the bubbles.
Thin glass is used because temperature changes can S-7 be sudden. This crystallization process allows a single magma to generate a range of igneous minerals and rocks. No, because the water from Venus has already been lost. From the greatest to the least temperature change, rank the following lapse rates for each kilometer of rising air: (a)
environmental lapse rate, (b) moist adiabatic lapse rate, (c) dry adiabatic lapse rate, (c) dry adiabatic lapse rate, (d) moist adiabatic lapse rate, (e) moist adiabatic lapse rate, (e) dry adiabatic lapse rate, (f) moist adiabatic lapse rate, (g) dry adiabatic lapse rate, (g
for rocket propulsion? We can understand how pressure in water depends on depth by considering a stack of bricks. THE SOL AR SYSTEM 723 FIGURE 26.23 Earth and the Moon as photographed in 1977 from the Voyager 1 spacecraft on its way to Jupiter and Saturn. Microscopic properties such as composition, crystal structure, and the strength of
chemical bonds determine a mineral's crystal form, hardness (resistance to scratching), fracture or cleavage (how a mineral breaks), color, and density. Water from the now-saturated air condenses on any available surface—a twig, a blade of grass, the windshield of a car, and so on. Graphite and diamond are polymorphs because they both consist
entirely of the same element, carbon, but the carbon atoms are arranged differently. In practice, sails are curved and produce an airfoil that is as important to sailcraft as it is to aircraft, as discussed in Chapter 5. (c) both of these (d) neither of these 9 C H A P T E R 9 Magnetism and Electromagnetic Induction M egan shows not only how a 9. What
kind of motion should you impart to the nozzle of a garden hose so that the resulting stream of water approximates a sine curve? Pseudoscience is "fake science" that doesn't meet scientific standards. Upon cooling, the water does not have its usual air content—hence, the fish drown. 10 turns 100 turns 100 turns 120 V 6V 6V = , so x turns = 500 turns
* 37. Without a keel, a sailboat could be blown sideways. (d) none of these 9. A crystal is a solid that has a crystalline structure—the atoms, ions, or molecules within it are arranged in a definite repeating pattern. CHAP TER 27 82. on it? To see how electrons are transferred in this reaction, we can look at each reactant individually. (a) Most glare from
nonmetallic surfaces is polarized. Yes, because the compass aligns with Earth's magnetic field, which extends from the magnetic pole in the Southern Hemisphere to the magnetic pole in the Moon is directly between the
Sun and Earth and the Moon's shadow is cast on Earth. Thus, nucleons lose mass in their transition from being in a uranium nucleus to being in one of its fragments. (If launched from the way.) 109. In the western United Ocean trench States, examples of such (convergence)
INTERACTIVE FIGURE A ball gains the same amount of speed in equal intervals of time. He suspected that Mesmer's patients did benefit from his ritual, but only because it kept them away from the bloodletting practices of other physicians. The atmosphere, much like the water in a lake, exerts a pressure. Na. .Mg. . This scenario is known as the
giant impact theory of the origin of Earth's Moon. But impurities in corundum give us rubies and sapphires (Figure 20.10). The conveyor-belt model by illuminating the driving forces that feed a midlatitude cyclone. Of course, each bottle would have to come with the instruction "Just add distilled
water." Would you want to push it by adding the word Pure to your label? Just as most of an iceberg is below sea level, likewise for mountains. Oxygen, O2, dissolves quite well in a class of compounds known as liquid perfluorocarbons—so well that oxygenated perfluorocarbons can be inhaled in a liquid phase, as is demonstrated by the rodent shown
below the water-bound goldfish. The Computerized Test Bank for Conceptual Physical Science has more than 2400 multiple-choice questions as well as short-answer and essay questions. The released fluid can then chemically react with the surrounding rock, contributing constituents to new minerals that are forming. CHECKPOINT How many
protons are there in an iron atom, Fe (atomic number 26)? The tinier the particle, the higher the frequency of light it will re-emit. Water freezes at 0°C and 32°F, and boils at 100°C and 212°F. Entropy is always increasing. (c) the equator. from molecule A, 6. A physicist defines heat as the thermal energy transferred from one thing to another due to a
temperature difference. Try this and see (feel) for yourself. The third prong connects the body of the appliance directly to ground. Why doesn't the gravity that acts on the bowling ball change its speed? The filling of hot apple pie may be too hot to eat, even though the crust is not. You not only see what's there—you see what's not there! The light
receptors in your retina do not connect directly to your optic nerve but are instead interconnected with many other cells. Granite is a plutonic rock. Just after an alpha particle leaves the nucleus, would you expect it to speed up? In which of the circuits does a current exist to light the bulb? Very little absorption occurs. CHECKPOINT Of the asteroid
belt, the Kuiper belt, and the Oort cloud: 1. They, like fossil fuel furnaces, do nothing more elegant than boil water to produce steam for a turbine (Figure 13.26). Rather, they are computer renditions generated from the movements of an ultrathin needle. What colors do you see in the image of the flag that appears on the wall? We can answer this
question by looking at the behavior of its atoms. This is an example of nitrogen fixation, which you may have explored already in a course on the life sciences. Some people think that electricity is a primary source of energy. Most contain little gas and dust, which makes them easy to see through. (It is moving at a 45° angle.) 47. 8 Clear glass blocks
both infrared and ultraviolet, but it is transparent to all the frequencies of visible light. A car races on a circular track of radius r. A highly concentrated solution of sucrose in 160 water, for example, can be made by heating the solu140 tion almost to the boiling point. Special thanks to Tracy, Ian, Evan, and Maitreya Suchocki for their continued
support. Because a full wavelength has two segments, you have three complete wavelengths in your standing wave. This cross-platform DVD set provides instructors with the largest library available of purpose-built, in-class presentation materials, including all the images from the book in high-resolution JPEG format; Interactive Figures™ and videos;
PowerPoint® lecture outlines and clicker questions in PRS-enabled format for each chapter, all of which are written by the authors; and Hewitt's acclaimed Next-Time Questions in PRS-enabled format. CHAPTER 8 1. The bond energies of the bonds being formed, therefore, are also different from those of the bonds that were broken. Entropy has nothing to do
with what our minds perceive as being orderly or disorderly. If liquid pressure were the same at all depths, would there be a buoyant force on an object submerged in the liquid? To produce a transverse wave with a Slinky, shake it to and fro in a direction that is perpendicular to the length of the Slinky itself (as with the garden hose in the preceding
exercise). If you're in a car at rest that gets hit from behind, you can suffer a serious neck injury called whiplash. For example, if a stream's speed stays the same while the discharge increases, the stream carries more water and so can carry more sediment. Many of the natural product molecules synthesized by photosynthetic plants are formed by the
joining together of isoprene monomers via an addition polymerization. The oxygen we breathe, O2, is odorless and life-giving. For a home that now costs $200,000? Politics also affects recovery after an earthquake, and this can lead to heated debate on many levels. Interestingly, the source of electrons in the current that shocks you is your own body.
Here the net force is F - f. We won't treat this secondary bow except to say that it is formed by similar circumstances and is a result of double reflection within the raindrops (Figure 13.32. Different-sized symbols are used to indicate the relative masses and resulting
accelerations. Some areas are better absorbers of solar radiation than others, so they heat up more guickly. Likewise, a carbon atom can attract four additional electrons and is thus able to form four covalent bonds, as occurs in methane, CH4. Watch for color changes, Like visible light, a gamma ray is pure energy. Depending on the size and weight of
packages dropped from airplanes, 160 km/h (100 miles per hour) is a typical terminal speed. The logarithm of any number smaller than 1 (but greater than zero) is a negative number. Electron loses potential energy and moves closer to nucleus. If the water level in the dish remains unchanged from one day to the next, can you conclude that no
evaporation or condensation is occurring? The factors show us that, physiologically speaking, alpha particles are 10 times as damaging as beta particles. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 92. Because melted gold is still gold but in a different form, its melting represents only a physical change. Another type of disposable
battery, the more expensive alkaline battery, shown in Figure 18.25, avoids many of the problems of dry-cell batteries by operating in a strongly alkaline paste. Standing waves can be produced with either transverse or longitudinal vibrations. (b) Note that the mass cancels, so the same temperature holds for a ball of any mass, assuming half the heat
generated goes into warming the ball. Zinc has a slightly greater tendency to oxidize than does iron. To land within the tennis court, the ball must not be moving too fast. 2. Temperature is a per-particle property; thermal energy is related to the sum total kinetic energy of all of the particles in your sample.** Twice as much hot water has twice the
thermal energy, even though its temperature (the aver(a) Translational motion age KE per particle) is the same. A pronounced temperature difference exists between the warmer east side of the system and the colder west side. Gravitational pressures in the outer layers are insufficient to produce fusion. (c) weight. Because all quasars are so very far
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away, they occurred a very long time ago—up to 13 billion years ago, which was close to the beginning of the universe. Sound from the instrument follows the line of sight to the reflector and then to you. For a single home or a small village, this surface area requirement may be easily accommodated. It wreaks havoc not only by suction but also by the
battering power of its whirling winds. CHECKPOINT Which are larger: atoms of cesium, Cs (atomic number 86)? We say that the orbiting bodies interact with the force fields of the planet and proton and are everywhere in contact with these fields. Try this with a friend. A variety of techniques exist for
attaining high temperatures. FIGURE13.19 Tracks of elementary particles in a bubble chamber, a similar yet more complicated device than a cloud chamber. LEARNING OBJECTIVE Describe the three types of plate boundaries. But it would be daytime on Earth, and the sky would be so bright and the new Moon so dim that people wouldn't see a
thing. Living organisms rely on special types of catalysts known as enzymes, which allow exceedingly complex biochemical reactions to occur with ease. The force of friction is 60 N, because when the desk is moving at constant velocity, \boxtimes F = 0. There is no one scientific method. When we enjoy a good meal, we give little thought to the technology that
went into growing, harvesting, and delivering the food on our table. Instead, fluorine's nuclear pull When this atom gains an electron, on the valence electrons is strong enough to accommodate even an additional the result is a negative ion. If the water molecule in Figure 15.35b were removed, the oxygen molecule would return to its normal
nonpolar state. Even surfaces that appear to be smooth have irregular surfaces when viewed at the microscopic level. Whatever the route, molten rock rises from the depths of Earth, cools, and solidifies to form a crust that, over eons, is reworked by shifting and erosion, only to return eventually to become magma in Earth's interior. The old one you
left six sentences ago is now ever so distant. When you are driving at 90 km/h, how much more distance do you need to stop than if you were driving into a pool, as shown in Figure 17.22, we have the sense that time is moving forward. resulting in the formation
of product. The pitch will increase as it approaches them, and decrease when it recedes. LEARNING OBJECTIVE Describe how color depends on the frequency of light. There is often some confusion between charge flowing through a circuit and voltage placed, or impressed, across a circuit. Atmospheric resistance is the factor that most determines
orbiting altitude. According to Newton, tossed balls curve because of a force of gravity. Progressing beyond hydrogen, the mass M jumps from a height h onto the right end of the seesaw, thus propelling Art into the air. The energized electrons re-emit the
light by which we see the page. In humid locations, the rate of condensation is higher, perhaps as high as the rate of evaporation. The structure of ethane is made by joining the carbons of two methane molecules (minus two hydrogens). All intrusive igneous rock bodies are called plutons. After a while, a nova subsides until enough matter accumulates
to repeat the event. Although it usually provides a brilliant display, its last visit in 1986 was not so spectacular when viewed from Earth. The momentum) of the cannonball and the cannonball and the cannon are equal in magnitude and opposite in direction.* They cancel to zero for the system as a * Here we neglect the momentum of ejected
gases from the exploding gunpowder, which can be considerable. What feature of clastic sedimentary rock enables the flow of oil after it has been formed? Jupiter's mass is greater than the combined masses of all the other planets. The attractive strong nuclear force exerted by all nucleons is able to overcome the repulsive electric force of protons. In
the process of water vapor condensing in the air, the slower-moving molecules are the ones that condense. Each of these terminal functional groups in the two-monomer unit is now free to link with one of the functional groups in the two-monomer unit is now free to link with one of the functional groups in the air, the slower-moving molecules are the ones that condense. Each of these terminal functional groups in the air, the slower-moving molecules are the ones that condense.
apparent brightness compare? LEARNING OBJECTIVE Connect and extend the law of gravity to areas beyond science. Your body creates chemical energy is absorbed by the liquid. How about a carbon dioxide molecule? This is evident in the diminished
redness of the coal after your foot has left it. We see the aftermath of meteoroid bombardment on the Moon because it wears no makeup. Weathering is the disintegration or decomposition of rock—in place—at or near Earth's surface. This makes its daytime very long and very hot, with temperatures as high as 430;;;C. Some Think and Rank questions
analyze trends, as in ranking atoms in order of increasing size based upon student understanding of the periodic table. Because atoms are invisible, however, we cannot use a physical model to represent them. Methyl salicylate is responsible for the smell of wintergreen and is a common ingredient of hard candies. C H A P T E R 17 453 9. The Moon
shows us different amounts of its sunlit half as it circles Earth each month. Combining 40 g of oxygen with 28 g of nitrogen would be 8 g too SAM PLE PROBLEM 4 much oxygen. Get it? Wrapping the potatoes in aluminum foil retains the heat after the potatoes are removed from the oven. The difficulty is separating enough U-235 from the more
abundant U-238. For the "strike anywhere" match, a third ingredient, red phosphorus, P4, is included. Because the air from the air conditioner is very dry, it clears a foggy windshield very nicely in a very short time. Consider a pulse of laser light aimed at the Moon that bounces back to Earth. Nitrogen atoms and hydrogen atoms join to make the
compound ammonia, which is a common household cleaner. Observations from a carousel, for example, are different when it is at rest. Which element within a compound is given first in the 
as visible light. 2 413 2 Al(OH)3 3 CaSO4 Aluminum sulfate Impurities captured by aluminum hydroxide as it settles. A material is a mixture if it contains more than one substance. Both are still mysterious and may yet be disproven by new evidence or alternate explanations. Nothing is permanent. In a common iron nail, for example, the domains are
randomly oriented. Minerals combine to make rocks—the igneous, sedimentary, and metamorphic rocks that we see all around us. A weather map is covered with lines—isobars—that connect points of equal pressure. This type of fault is called a reverse fault. (c) At lower consumption rates, the same resource lasts a longer time. What you see with
the binoculars is mostly the central core. With the nonpolar tails facing inward toward the grime, the polar heads are all directed outward, where they are attracted to water molecules by relatively strong ion-dipole attractions. Which is the oldest element? In this case, hydrogen chloride behaves as an acid (proton donor) and water behaves as a base
(proton acceptor). How does the average speed of light in glass compare with its speed in a vacuum? When your whistle is confined to the tube, the consequence is a quantization of its frequencies. Consider, a bob attached by a string, a simple pendulum, that swings to and fro. Place a large pot of cool water on top of the stove, and set the burner on
high. The peak frequency of sunlight is yellow-green, which is also the color that our eyes are most sensitive to. He reasoned that if an object falls for, say, twice the time, it will fall with twice the average speed. Long wavelength 103 m 102 Hz 104 Hz 106 nm Microwaves 106 Hz INTERACTIVE FIGURE The electromagnetic spectrum is a continuous
range of waves extending from radio waves to gamma rays. Contrary to popular opinion, the entropy of a deck of playing cards has nothing to do with whether or not it has been shuffled. The Milky Way is actually about 28% helium. How does the direction of a friction force compare with the direction of the velocity of a sliding object? Avogadro's
number The number of particles—6.02 * 1023— contained in 1 mole of anything. Batteries generate electricity as the chemical reactants they contain are reduced and oxidized. Another example is the Cigar galaxy, M82, which is being deformed by the tidal forces from its much larger neighbor, M81 (Figure 27.31). Triton's diameter is three-quarters
of our Moon's diameter, and yet Triton is twice as massive as Earth's Moon. -- 5th ed. People seem to have a hard time accepting the impossibility of zero risk. Because evaporation rate > slower-moving molecules characterize lower air temperatures, saturacondensation rate tion and condensation are more likely to occur in cool air than in warm air
(Figure 25.2). As humans we are nicely situated between these two extremes. The fact that the stream is deflected in the same way by both a negatively and a positively charged object indicates that the deflection is due to charge polarization. What does it mean to say that one wave is out of phase with another? at first, but if you continue adding
sucrose to a glass of water, you'll see that the water level rises, just as it would if you were adding sand. ** Interestingly, frost is not frozen dew. The number 0 is assigned to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the temperature at which water freezes, and the number 100 to the number 10
g of N2 is 1 mole of N2 and 32 g of O2 is 1 mole of O2. The amount of radioactive fertilizer taken up by the plants can be easily measured with radiation detectors. 59. Having spent all of its nuclear fuel, our dead Sun, now quite small, will no longer be producing energy. They no longer give light, while bulb C glows as before. What do you suppose is
generally true about the ability of atoms connected by a carbon-carbon triple bond to twist relative to each other? In a humorous vein, does it follow that your oppositely charged head would also stick to the wall? When this transmutation occurs, energy is released, partly in the form (b) F I G U R E 1 3 .1 6 Some radiation detectors. This illustrates
Newton's first law—the law of inertia. Which depends on distance: a star's brightness or its luminosity? The heat from the evaporation. Red is scattered only a tenth as much as violet. With the addition of small amounts of iron and titanium, the result is the blue gemstone sapphire. The alloy known as brass is a solid solution of
copper and zinc, for instance, and the alloy stainless steel is a solid solution of iron, chromium, nickel, and carbon. By studying the passage of both P- and S-waves through Earth, scientists can identify the solid and liquid layers. Change the angle of the mirrors and see how many images of the coin you can see. 15.4 Metallic Bonds 10. That's right, the
water is cooler than it would be if it didn't boil. If uranium were to split into 90 pieces of equal size instead of 2, would more energy or less energy be released? But that doesn't prevent us from thinking about such things or even collecting indirect evidence. Identify all the functional groups in these four molecules (ignore the sulfur group in penicillin
the ore is imbedded. Faults are classified based on the relative direction of displacement (movement). A station at 101.7 MHz on the FM dial broadcasts radio waves with a frequency of 101,700,000 hertz. Unless the vapor pressure is great enough, the surrounding pressures collapse any bubbles that tend to form. A small rise in the water level would
be ambiguous and make a water thermometer impractical in this temperature region. During totality, what appears in the sky is an eerie black disk surrounded by the pearly white streams of the corona, as was shown in Figure 26.7. It is an experience one can never forget. Hence, such a cloud can only be imagined. In Section 12.7, for example, you
will be introduced to the planetary model of the atom, wherein electrons are shown orbiting the atomic nucleus much as planets orbit the Sun. The wax layers represent sedimentary layers. The balanced equation representing this reaction is 3 NH4ClO4 + 3 Al h Al2O3 + AlCl3 + 3 NO + 6 H2O + energy CHECKPOINT Recall from Chapter 2 that for
every action there is an opposite and equal reaction. Sound reflects from a smooth surface in the same way that light does—the angle of incidence (the angle of reflection (Figure 10.11). We can see, in Figure 3.18, F I G U R E 3 .18 The potential energy
of the 10-N ball is the same (30 J) in all three cases because the work done in elevating it 3 m is the same whether it is (a) lifted with 10 N of force, (b) pushed with 6 N of force up the 5-m incline, or (c) lifted with 10 N of force, (b) pushed with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force, (b) pushed with 10 N of force, (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force, (d) pushed with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force, (e) pushed with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m incline, or (c) lifted with 10 N of force up the 5-m i
fewer heavy elements than our Sun contains. Redistribution of land and water affects the world's climate—the oceanic and atmospheric circulation relates to wave orientation. The solar system is like an atom in that both (a) are governed principally through the electric force. The quality
of the white gold can \mu Mh Mh be modified simply by changing the proportions \mu of gold and palladium. To go backward—from the compound back into the elements—would also be a chemical change. (b) If the cart's mass is 4.0 kg, the applied force is 12.0 N, and the friction force is 6.0 N, show that the cart's acceleration is 1.5 m/s2. Why are
compact fluorescent lamps (CFLs) more efficient than incandescent lamps? Hewitt 133: Shutterstock 136: Paul G. Half of the liquid left behind in the cloth can
easily drop below the temperature of the cool water that wet it in the first place. From the formula mass, you know that 1 mole of water has a mass of 18 g. Note the remnant arms that suggest two former spiral galaxies. (a) Yes, ball B rolls faster along the lower part of the track. For the case of an object that is small compared with the radial distance
to its axis of rotation, like a tetherball swinging from a long string or a planet orbiting around the sun, the angular momentum and the sun, the angular momentum = mvr. He restrained himself publicly for nearly 15 years. Only a
small amount of blue is scattered, which makes the Sun appear yellowish. To tune a piano, for example, a piano tuner listens for beats produced between a standard tuning fork and those of a particular string on the piano. Lab manual author Dean Baird's student, Robin Eitelberg, opens Chapter 8 on page 186. * Contrast this to the gravitational force
of attraction between two 1-kg masses 1 m apart: 6.67 * 10-11 N. Boxes of various masses are on a friction-free level table. 115. Discuss this phenomenon first in terms of density and then in terms of weight versus buoyant force. Why is Earth called "the blue planet"? The condensation of molecules in the can leaves behind a vacuum. Will they
separate and fall differently? The lithosphere moves along with the motions of the material beneath it in the asthenosphere. 6.8 Thermal Expansion 26. The nitrogen atom becomes radioactive carbon-14. Most of the protons are stopped as they collide with the atoms of the upper atmosphere, stripping electrons from these atoms to become hydrogen
atoms. v 1.25 m v=? B, C, A. Sandstone, shale, and limestone are common sedimentary rocks. People who live in brick, concrete, or stone buildings are exposed to greater amounts of radiation than people who live in brick, concrete, or stone buildings are exposed to greater amounts of radiation than people who live in brick, concrete, or stone buildings.
nature and even society should be searched to discover any "natural laws" that might exist. Often, they cluster in groups as shown in Figure 26.5. The Sun spins slowly on its axis. The work-energy theorem emphasizes the role of change. We begin by taking a closer look at the stars visible to our unaided eyes. According to the following calculation, 16
g of CH4 requires 64 g of O2: (16 g CH4)(1 mole CH4)(2 moles O2/1 mole CH4)(2 moles O2/1 mole CH4) (32 g O2/1 moles 
the rate is about 6.5°C for each kilometer rise in elevation. Biology is more complex than physical science, for it involves matter that is alive. The longer you leave the string undisturbed in the solution, the larger that is alive. The longer you leave the string undisturbed in the solution, the larger that is alive. The longer you leave the string undisturbed in the solution, the larger that is alive.
bends away from the normal is light that has (a) slowed down. Imagine a string attached to the top of your head lifting you upward. Forces, whether large shoves or slight nudges, always occur in pairs, each opposite to the other. They also tend to be yellow, which tells us that they consist primarily of older stars—older stars are yellow, while hot
young stars tend to be blue. It applies to impulses, too. P olymers are exceedingly long molecular units called monomers, as Figure 19.25 illustrates. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 101. When the foci are together at one point, the ellipse is a circle. Our eye concentrates on the boundary
where the dark edge of the left rectangle joins the light edge of the right rectangle, and our eye-brain system assumes that the rest of the rectangle is the same. The Richter magnitude scale, which measures the energy released by an earthquake in terms of ground shaking, was the first widely used magnitude scale. 2 Minerals 20. What will be the
next step in reducing friction between vehicles and the surfaces over which they move? What happens when the person's work and heat output is greater than the energy consumed? Rock cycle A sequence of events involving the formation, destruction, alteration, and reformation of rocks as a result of the generation and movement of magma; the
weathering, erosion, transportation, and deposition of sediment; and the metamorphism of preexisting rocks. Theorists at Princeton, working around the same time as Penzias and Wilson, showed that if the universe began in a primordial explosion as described by the Big Bang, it would still be cooling off. These giant magnetic fields make up an
important part of the cosmic energy store and play a significant role in shaping the evolution of galaxies and large-scale grouping of galaxies. FIGURE 25.3 San Francisco is well known for its summer fog. The small amount of ultraviolet light that does penetrate causes sunburns. The rotating loops of wire in the armature cut through the magnetic
field of the surrounding electromagnets, thereby inducing alternating voltage and current. Water evaporating from your body takes energy with it, which is why you feel cool when emerging from water on a warm and windy day. Yes, just as every coin has two sides, a "head" and a "tail." (Some "trick" magnets have more than two poles, but none has
only one.) * The force of interaction between magnetic poles is given by F \( \rho \) (p1p2)/d 2, where p1 and p2 represent magnetic pole strengths and d represent magnetic poles is given by F \( \rho \) (p1p2)/d 2, where p1 and p2 represent magnetic poles is given by F \( \rho \) (p1p2)/d 2, where p1 and p2 represent magnetic poles is given by F \( \rho \) (p1p2)/d 2, where p1 and p2 represent magnetic poles is given by F \( \rho \) (p1p2)/d 2.
principle. Heat is thermal energy in transit. Previously, we stated that a force was a push or pull; now we say it is an interaction. Astronomy is a science dedicated to the study of celestial objects. The unit of measure for radiation dosage in rems, we multiply
the number of rads by a factor that corresponds to different types of radiation determined by clinical studies. You can count the number of atoms in the models to see this for yourself by performing the following two activities. Since the
temperatures of water in the pan and in the inner container are the same, no heat passes from the water in the pan to the water in the pan to the water in the pan and in the inner container are the same, no heat passes from the water in the pan to the water in the pan and in the inner container are the same, no heat passes from the water in the pan to the water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container. Which has the greater mass: 1.204 * 1024 molecules of molecules of water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container. Which has the greater mass: 1.204 * 1024 molecules of water in the pan and in the inner container. Which has the greater mass: 1.204 * 1024 molecules of water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container are the same, no heat passes from the water in the pan and in the inner container are the same are th
desk across a classroom floor. (b) Here we simply substitute the numerical values given: F - f 12.0 N - 6.0 N = m 4.0 kg N = 1.5 m/s2 = 1.5 kg a = (The units N/kg are equivalent to m/s2.) Note that the answer, about 15% of g, is "reasonable." For more on units of measurement and significant figures, see your Lab Manual. Protons and neutrons are
bound together at the atom's center to form a larger particle—the atomic nucleus. Projected by some means and continues its motion by its own inertia. These heavy isotopes, however, were forged within past supernovae. The more quickly it moves, however, the more quickly it moves, however, the more its behavior is that of a wave of energy. These are the
additive primary colors. EXERCISES (SYNTHESIS) 60. (b) increases and its acceleration decreases. Because many alkaloids have medicinal value, there is great interest in isolating these compounds from plants or marine organisms that contain them. Tertiary treatment removes pathogens and wastes not removed by earlier treatments by
filtering the effluent through beds of powdered carbon or other fine particles. Pseudoscience Fake science that pretends to be real science that pretends to be real science. The only requirement is that the monomer must contain a double bond. Actually, the boiling process cools the water. And when seismic waves pass into a different material, their wave speed changes, causing the
wave to refract (Chapter 10). A force external to the ball, such as batting it, is needed to accelerate it. Nebular Theory Any theory of solar system and (2) the division of planets into two main types—terrestrial and Jovian. These fire-
resistant substances were known to the alchemists as "earth." As a holdover from these ancient times, group 2 elements are known as the alkaline-earth metals. FIGURE 5.3 This water tower does more than store water. T H I N K A N D R A N K (A N A LY S I S) 68. Earth's atmosphere is transparent to some ultraviolet light, to all visible light, and to
some infrared light. That is, V = ItotalReq. • An instructor resources section with PowerPoint lectures, clicker questions, Instructor Manual files, and more. An Englishman and a Frenchman, J. The minerals opal and fluorite and some phosphates can also be precipitated by organisms. In sodium chloride, for example, each sodium ion is surrounded by
six chloride ions, and each chloride ion is surrounded by six sodium ions (Figure 15.11). Does this indicate that support force need not be related to gravity? density * g * vol F 63. All bullets drop equal distances in equal times, whatever their speed. Eventually the acceleration will become zero, in which case the diver has reached terminal velocity.
Thus, we can see why the gas pedal is called the "accelerator"! * The Greek letter © (delta) is often used as a symbol for "change in time (the time ©t interval). Others, like the one shown in Figure 27.27, have a hub shaped like a bar. Not all
collisions between reactant molecules lead to products, however, because the molecules must collide in a certain orientation in order to react. F I G U R E 1 8 .1 6 Carbon dioxide forms carbonic acid on entering any body of water. A moving truck has more momentum than a car moving at the same speed because the truck has more mass. Rather than
recede forever, it will take up an orbit around the Sun. When can a burnt-out collapsing star rekindle itself? The first law of thermodynamics makes good sense.* The second law of thermodynamics makes good sense.* The second law of thermodynamics makes good sense.*
half of the carbon-14 atoms that are now present in a plant or animal that dies today will decay in the next 5730 years. For this reason, electron pairs in an electron-dot structure are called nonbonding pairs. The current is greater in the bulb connected to the 220-V source. It is important to ask: Is growth really good? rays (dashed lines) converge.
Consider the different meanings of the word uncertainty. Because of gravity, however, the path curves of the rift area. If a friend commented that a hydraulic device is a common way of multiplying energy, what would you say? The Cascade Range,
produced from the subduction of the Juan de Fuca Plate (a piece of the old Farallon Plate) beneath the North American Plate, includes the volcanoes Mt. Rainier, Mt. Shasta, and Mt. St. Helens. Even so, earthquakes can happen anywhere in the world, and not always along plate boundaries. The equations are quides to thinking that show the
connections between concepts in nature, 468 PARTTWOCHEMISTRY FIGURE 18.14 (a) The damaging effects of acid rain do not appear in bodies of fresh water lined with calcium carbonate, which neutralizes any acidity, (b) How fast is this in m/s? As gravity pulls the oldest edge of the subducting slab into Earth's interior, the rest of the
subducting plate is also pulled trenchward—this process is called slab-pull. Its atoms are rather loosely bonded. Is there a speed at which the ball will clear the gap (like a motorcyclist who drives off a ramp and clears a gap to meet a ramp on the other side)? The greater the redshift, the greater the velocity of the receding galaxy.
What color would you get if a teaspoon of concentrated broth were added to a glass of water? In fact, only about a dozen minerals make up most of the rocks exposed at Earth's surface. Rank the following reaction profiles in order of increasing reaction profiles in order of increasing reaction speed.
container of water and measure the volume of displaced water. (b) The induced dipole-induced dipole molecular attractions are stronger. At 30./kWh, what does it cost to operate the 1200-W hair dryer for 1 h? Toward the upper right of the diagram is a distinct group of stars—the giant stars. So the distance between the first and second dots is 5 mm
clouds. The safety net reduces the force experienced by a fallen acrobat by substantially increasing the time interval during which the force acts. But a solar eclipse can be seen from only a small part of the hemisphere that faces the Sun at that time. If sufficient oxygen had been present in the depositional environment, bacteria would have
decomposed the organic matter very quickly. FIGURE 8.28 This table lamp has an insulating body and doesn't need the third (ground) wire. Because the apparent path of polar movement varied from continent, it was more plausible that the continents had moved. The number of public water treatment facilities in developing nations,
however, is relatively small. It would likely burn out. h Na Cln Nah Cln In-dipole attraction Aqueous solution of sodium chloride highly electronegative atom, usually nitrogen, oxygen, or fluorine. Note the randomness of threads inside the cylinder of
Figure 8.11d, where no field exists. There are two horizontal forces on the car: road friction acting on the tires and air resistance in the opposite direction. But mass doesn't depend on gravity. (c) If 250 g of sucrose is mixed with 100 mL of water at 20°C, 50 g of sucrose remains undissolved. Igneous rock, for example, may be subjected to heat and
motor oil molecule. Both pool and billiards offer a first-rate exhibition of momentum conservation in action. Dip some plastics of these two polymers in boiling water to find out. This method of heat transfer is called conduction. 446 PA R T T W O CH E M I S T RY energy, which must come from some external source, such as electromagnetic radiation,
reaction? The momentum changes from 16 kg # m/s to zero. CHAP TER 27 27.5 Black Holes 19. Are induced dipoles permanent? 17.2 Counting Atoms and Molecules by Mass 5. How many groups? How does the total current through the branches of a parallel circuit compare with the current through the voltage source? SAM PLE PROBLEM 2 Our
distance from the center of the Milky Way galaxy is about 26,000 light-years. They also have successfully cleared all debris from their orbital paths. What is the law of reflection for sound? Only because the deflection by Earth is so tiny and too small to measure. Water reacts when exposed to electricity to form hydrogen gas and oxygen gas. A
chemical that loses a hydrogen ion is behaving as an acid. The instantaneous speed of light before it meets the glass, while passing through it, and when emerging is a constant, c. The table exerts this upward force, called the support force. The figure uses the convention of up being + and down being - . FYI Notice that a brightness of 1 is four times
as great as a brightness of 0.25. An electric razor completes 60 cycles every second. If an object's kinetic energy is zero, what is its momentum? The fourth week? 19.5 Amines and Alkaloids 14. Shaken by the quake, the loose, soft sediment behaved like a slushy jello—liquifaction—and was unable to support structures. Viewed in the reverse direction
the equation shows that the ammonium ion behaves as an acid because it donates a hydrogen ion to the hydroxide ion, which therefore behaves as a base. Ouch! 67. Silver heats more quickly and has the higher specific heat capacity. We see a comparison of interference for transverse waves and for longitudinal waves in Figure 10.22. Upon heating,
following interactions, identify the action and reaction forces. FYI Hurricanes In the steamy tropics, where the Sun warms the oceans, heat transfer to the atmosphere by evaporation and conduction is so thorough that air and water temperatures are about equal. TA B L E 1 9. ght te li Whi Wh ite light Prism (cross section) Diffraction grating (cross
section) (a) LEARNING OBJECTIVE Describe how an atom reveals its identity by the light it emits. Osmosis transfers fresh water to fresh water into salt water, but reverse osmosis transfers fresh water to fresh water into salt water. Wavelength The distance between successive crests, troughs, or identical parts of a wave. The way the table is organized, for example, tells us much
about the elements' properties. When a ball rolls down an inclined plane, it gains speed because of gravity. What evidence would prove this idea wrong? In a uranium nucleus, however, each of the 92 protons feels the repulsive effects of the other 91 protons! The nucleus is unstable. After the shaking is stopped, the liquids separate into two layers,
much like oil and vinegar. Just as a person who knows the rules of botany best appreciates music, you'll better appreciates music, you'll better appreciates music, you'll better appreciates from the intricacies of music best appreciates music, you'll better appreciate music music music, you'll better appreciate music music music music, you'll better appreciate music mus
the copolymerization of ethylene glycol and terephthalic acid, as shown in Figure 19.33. Amplitude is likely increasing. Why is heat measured in joules? Plus the Hey Megan, the seashore atmosphere shields us from harmful UV rays. 226 0 1. Interestingly, the stars themselves have intrinSouth North sic motion. If we call the force on the bat against
the ball the action force, identify the reaction force. (b) a current-carrying wire experiences force in a magnetic field. Once in your stomach, it mixes with everything else to make up a nutrient-filled solution. LEARNING OBJECTIVE Distinguish between series and parallel circuits. W hat happens when a mass of rock is brought to a location that has
much higher temperature and pressure than the environment in which it formed? This may happen when sound travels through air of uneven temperatures. Four crates will sink the barge. Minerals are the building blocks of rocks, and elements, in turn, are the building blocks of minerals. The
surfaces of these stars can be hotter than the Sun, which makes them blue or white. Solution: (a) We want the time of the ball in the air. What happens next is an astounding event called a supernova. Then the waves are steadily in and out of phase with each other and produce stable regions of constructive and destructive interference (Figure 10.27)
6 Chemical Reactions Are Driven by Entropy T he heat of a lightning bolt causes multiple chemical reactions in the atmosphere, including one in which nitrous acid, HNO2. Although blood protein is weakly diamagnetic and is repulsed by magnetic fields, the magnets used in
magnetic therapy are much too weak to have any measurable effects on blood flow. The universe as we know it, therefore, had a beginning. Once thermal energy has been transferred to an object or substance, it ceases to be heat. Good cooks know that the reason for the rapidly boiling water is not higher temperature, but simply a way to keep the
spaghetti strands from sticking together. Pascal's principle applies to all fluids, whether gases or liquids. Because of the large size of the Sun, the rays taper to provide an umbra and a surrounding penumbra, as shown in Figures 26.30 and 26.31. Energy expended becomes thermal energy. If the lightbulb is connected to a wire loop that intercepts
changing magnetic field lines from an electromagnet, voltage will be induced, which can illuminate the bulb. They play a key role in global climate. To date, we know of slightly more than 100 distinct atoms. Why is it important never to change a subscript in a chemical formula when balancing a chemical equation? Upwarping FIGURE 21.22 (a)
Continental crust Lithosphere Rift valley (b) Linear sea (c) -> Formation of a rift valley and its transformation into an ocean basin. CHAPTER 15 1. When an element ejects a beta particle from its nucleus, the mass of the atom is practically unaffected, meaning there is no change in mass number, but its atomic number increases by 1. You understand
that the oxygen atom has 8 electrons: 2 in the first shell and 6 in the valence shell. Nonpolar Polar FIGURE 15.23 C C C N C O 0.49 0.89 1.43 C F Electronegativity difference between atoms in an ionic bond can also be calculated. (b) is less than the evaporation rate. tion face, more water molecules are
available to migrate into the solution Water forced across a semipermeable membrane into a less concentrated soluthan are available to migrate into the goes beyond the Think and Solve questions. They breathe the O2 that is dissolved in the water. Objects undergo changes in
motion only in the presence of a net force. Earth will be stripped of its atmosphere and the oceans boiled dry. At divergent plate boundaries, earthquakes are generally mild and shallow. All waves have a vibrating source. Air flowing up and over tall mountains or rising in thunderstorms may change elevation by several kilometers. Net force is equal to
her weight minus her air resistance, and because air resistance increases with increasing speed, net force and hence acceleration decrease. Find the acceleration of the cart, and show that it moves a distance of 5 m. When water vapor condenses to liquid water, is heat absorbed or released? In Chapter 8, we'll learn that electric charge is conserved
which means that it can be neither created nor destroyed. An anticline folds upward like an arch. Rayleigh waves move in an up-and-down, rolling motion. B A C D Were these your answers? Also notable in our nighttime skies are the lunar eclipses, which can seen by anyone who happens to be on the nighttime side of Earth during the eclipse
(assuming skies are clear). What was the purpose of the silk covering? For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Absolute zero The temperature at which no further energy can be taken from a system. If the winds were easterly instead of westerly, the climate of San Francisco
would be chilled by winter winds from dry, cold Nevada. They lie outside the realm of science. Which of Aristotle's ideas did Galileo discredit in his fabled Leaning Tower of Pisa experiment? Do radio waves travel at the speed of sound, at the speed of light, or at some speed in between? As shown in Figure 12.11, there are 7 periods and 18 groups. F I
G U R E 1 6 .1 0 Blood plasma (a solution) White blood cells Red blood cells Blood (a suspension) 16.3 Centrifuge Solutions EXPLAIN THIS W What is the solvent in brown sugar? The resulting force on your bones is reduced by a factor of 10 to 20. Evidence of this ice sheet is found in thousands of wellContinent preserved glacial striations. Raise a
filled glass of water above the waterline, but with its mouth beneath the surface. In both cases, there is a dispersal of energy to the environment. In a heterogeneous mixwith the naked eye. The net force of air resistance. How is a barefoot fire walker able to walk
safely on redhot wooden coals? No battery or LEARNING OBJECTIVE Describe how Faraday's law is central to the industrial age. As the automobile moves? The wingsuit not only increases a diver's frontal area but also provides a lift
similar to that achieved by flying squirrels when they fashion their bodies into "wings." This exhilarating sport, wingsuit flying, goes beyond what flying squirrels can accomplish, since a wingsuit flying squirrels can accomplish, since a wingsuit flyer can achieve horizontal speeds * In mathematical notation, a = mg - R Fnet = m m where mg is the weight and R is the air resistance. We can represent
glass to its brim with the warm water, and then carefully pour all the water into the larger container. Convert moles of O2 to moles O2 = 1.33 moles O3 b 3 moles O2 = 1.34 moles O3 b 3 
role in determining whether an air parcel is stable or unstable. In Figure 1.23, we imagine a freely falling boulder with a speedometer attached to it. (More precisely, 9.8 m/s2.) This is the same as saying that acceleration is 10 meters per second. When the bus driver steps on the gas pedal, the vehicle gains speed. CHAPTER 25 1. The Sun
the Moon, and planets move relative to one another as they move across the backdrop of the stars. How about a planet five times as far away as Earth? (b) Pumice. The plates move in different directions, and neutrons). This is done by mixing the
water with certain minerals, such as slaked lime and aluminum sulfate, which coagulates into a gelatinous material, aluminum hydroxide, that intersperses throughout the water (Figure 16.27). Salt in water separates into sodium and chlorine ions. N. All of these artificially made elements have short half-lives. The fundamental difference between a
bullet fired through a board and light passing through glass is that in the case of the bullet, the same bullet strikes and later emerges. But cover the edge with your pencil or your finger, and they look equally bright (try it now)! That's because both rectangles are equally bright; each rectangle is shaded from lighter to darker, moving from left to right
Representations of plane-polarized waves. Just as the permanent dipole can do the same thing. For example, depending on conditions, an iron atom may lose two electrons to form the Fe2+ ion, or it may lose three electrons to form the Fe3+ ion. Which gives us the
most meteorites? A protostar with a mass less than 0.08 times the mass of the Sun (0.08MSun) never reaches the 10 million K threshold needed for sustained fusion of hydrogen. Can you think of an explanation? Water's high specific heat capacity helps keep Europe's climate appreciably milder than regions of the same latitude in northeastern regions
of Canada. CHAPTER 2 the force pair is internal to the orange-apple system. Speed is how fast something moves, or the time rate of change of position (excluding direction): a scalar quantity. Each standing wave corresponds to one of the permitted energy levels. This is unstable air. What chemistry does the body use to get rid of molecules it no
longer needs? In many cases the intention of particular exercises is to help you apply the ideas of physics to familiar situations. When it comes to star per year. CHAP TER 27 S TA R S A N D G A L A X I E S 759 F I G U R E 2 7. If you push against a box on a
floor and the box doesn't slide, then no change in its energy tells you that you are not doing work on the box. An important unsaturated hydrocarbon is benzene, C6H6, which may be drawn as three double bonds contained within a flat hexagonal ring, as shown in Figure 19.8a. Hearing of your physics skills, he asks you. 2 When you stick a nail into
ice, does cold flow from the ice to your hand, or does energy flow from your hand to the ice? Basic research Research that leads us to a greater understanding of how the natural world operates. If their axes are at right angles to each other (in this case, we say the filters are crossed), almost no light penetrates the pair (Figure 11.55b). The potential
difference between a storm cloud and the ground is 100 million volts. What is your more enlightened explanation? As we discuss in the following sections, scientists developed these models to help explain how atoms emit light. The transformation of elements into a compound is necessarily a chemical change. The Moon falls toward Earth in the sense models to help explain how atoms emit light.
that it falls (a) with an acceleration of 10 m/s2, as do apples on Earth. R E A D I N E S S A S S U R A N C E T E S T (R AT) If you have a good handle on this RAT. Why are saturation and condensation more likely to occur on a cold day than on a warm day? Perfume
molecules and their smell soon drift from the corner to all parts of the room. We can see how overloading occurs in Figure 8.32. Desert sand is very hot in the day and very cool at night. That is, over time, a nebula flattens, heats, and spins more rapidly as it gravitationally contracts. But the average velocity is zero. The rising air becomes saturated,
producing more precipitation. You'll also find coatings of these calcium and magnesium compounds on the inside surfaces of a well-used teakettle (because the solubility of these compounds decreases with increasing temperature, as discussed earlier). Figure 14.12 shows potassium chromate, a material whose color depends on its temperature. The
Greek letter omega, \( \), is commonly used as the symbol for the ohm. Oxygen, O2 bonding partners and form product molecules. Consider carbon dioxide, CO2, shown in Figure 15.25. What two physics mistakes occur in a science-fiction movie that shows a distant explosion in outer space that you see and hear at the same time? The cheese and butter
do not melt. The age of our galaxy can be estimated by looking at the positions of our oldest stars and their white-dwarf remnants. As air moves from a high-pressure region, it rises and cools, and the Weather Symbols Total Sky Cover Wind Entries No clouds Station model Common Weather Symbols Miles (Statute) per hour
Heavy snow Fog 21-25 18-22 33-40 Light drizzle Haze 26-31 23-27 41-50 Ice pellets (sleet) Smoke Seven-tenths or overcast with openings 32-37 28-32 51-60 38-43 33-37 61-69 Freezing rain Thunderstorm Sky obscured 44-49 38-42 70-79 Freezing drizzle Hurricane 50-54 43-47 80-87 55-60 48-52 88-96 61-66 53-57-60 48-52 88-96 61-66 53-57-60 48-52 88-96 61-69 Freezing drizzle Hurricane 50-54 43-47 80-87 55-60 48-52 88-96 61-66 53-57-60 48-52 88-96 61-69 Freezing drizzle Hurricane 50-54 43-47 80-87 55-60 48-52 88-96 61-66 53-57-60 48-52 88-96 61-69 Freezing drizzle Hurricane 50-54 43-47 80-87 55-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 48-52 88-96 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 53-57-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60 61-60
97-106 Rising, then steady; or rising, then rising more slowly Rising steadily, or unsteadily 250 Present weather 31 +28 Visibility 24 30 Dew 6 4 2 point .45 Type of low cloud Base height of low c
58-62 107-114 72-77 63-67 115-124 78-83 68-72 125-143 84-89 73-77 135-143 119-123 103-107 144-198 Barometric pressure reduced to sea level Pressure higher or lower than 3 hours Type of middle cloud Front Symbols Rising, then falling Wind direction Temperature Completely overcast
Pressure Tendency Wind speed Occluded front (surface) The weather during past 6 hours Amount of low clouds Stationary front (surface) Barometric tendency in last 3 hours ago Falling steadily, or
73 29 1016 77 69 49 22 72 70 1004 L 30° 69 66 70 68 75 72 77 71 80 74 79 73 73 70 69 25° 77 75 80 74 1016 25° 1012 76 70 1008 82 76 1012 120° 115° 110° 105° 100° 95° 90° 85° 80° CHAP TER 25 REVIEW 703 the probability of a weather condition—for example, the probability of rain is 70%. First, 25 W = 0.025 kW. When air is unstable, it
answer? Magma with high silica content flows more slowly because it is thicker and more gooey—it is more viscous than magma with a lower silica content. H 2 Li Be 3 Na Mg 11 4 29 C N O F Ne 13 14 15 16 17 18 Al Si P S Cl Ar 31 32 33 34 35 36 V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 41 42 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te 56
Ds Rg Cn Uut Uuq Uup Uuh Uus Uuo 58 6th-period subset 59 60 61 62 63 64 65 66 67 68 69 70 71 Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu 91 Th Pa 92 93 94 95 96 97 98 99 100 101 102 103 U Np Pu Am Cm Bk Cf Es Fm Md No Lr phenomenon of repeating trends is called periodicity, a term used to indicate that the
trends recur in cycles. Why this occurs is quite fascinating, and it will be touched on in the next chapter. If she directed vertically and at angles close to the vertical would still escape. Chemical reactions that occur in a photosynthetic
plant have a net absorption of energy. A balloon is suspended in water for the same reason: each is buoyed upward by a displaced weight of fluid equal to its own weight. When the velocity is doubled, the momentum is doubled and the KE is increased by a factor of 4. The dynamics of this process allow for an efficient
conversion of mass into energy, which would provide for colossal jets of highly energetic particles and light. As a result, atoms and molecules behave somewhat like optical tuning forks. In the position shown, the boat can sail faster than the speed of the wind. Without the horizontal temperature difference, the storm is without an energy source. (b)
perpendicular to the wave direction. This is to be expected, because the faster-moving molecules in less time. For each 1-degree increase in temperature above 0°C, the speed of sound in air increases by 0.6 m/s. Fear, however, usually arises from a lack of
understanding. The study volunteers were men and women 18 and older who had self-reported musculoskeletal pain at the beginning of the study. As you dilute the solution, the color grows lighter, but what happens to its hue? We do not see stars in the daytime because (a) the Sun blocks them. From greatest to least, rank the wires in how much
they'll sag on a hot summer day: (a) copper, a = 17 * 10-6/°C; (b) aluminum, a = 24 * 10-6/°C; (c) steel, a = 11 * 10-6/°C; (b) aluminum, a = 24 * 10-6/°C; (c) steel plates are commonly attached to each other with rivets. Floor tiles, shower curtains, and pipes are most often made of PVC, shown in Figure 19.30. 16. Hydrogen chloride, HCl, is a gas at room temperature. Both the
atmosphere of Earth and the glass in a florist greenhouse are transparent to incoming short-wavelength light and block outgoing long waves. Sound interference is dramatically illustrated when monaural sound is played by stereo speakers that are out of phase. Smaller reactors are easier to manage and can be used to build a generating capacity
suited to the community being served. Air becomes denser when it is compressed, and it becomes less dense when it expands. creases by 273 That's the lower limit of temperature, absolute zero. A city planning commission that accepts what seems like a modest 3.5 percent growth rate may not realize that this means that doubling will occur in 70/3.5
or 20 years; that's double capacity for such things as water supply, sewagetreatment plants, and other municipal services every 20 years. In larger aircraft, sound from the engines is processed and emitted as anti-noise from loudspeakers inside the cabin to provide passengers with a quieter ride. C H A P T E R 10 In phase 251 FIGURE 10.27 Incident
wave Node (null point) WAV E S A N D S O U N D INTERACTIVE FIGURE Reflected wave The incident and reflected waves interfere to produce a standing wave. The temperature at the bottom, for the same reason that rocks are at the bottom of any body of water that has 4°C water in it is 4°C at the bottom, for the same reason that rocks are at the bottom of any body of water that has 4°C water in it is 4°C at the bottom, for the same reason that rocks are at the bottom.
cold is absolute zero? Recall that a photon is a single discrete packet (a quantum) of radiant energy. Our universe was the Milky Way galaxy until Hubble pointed out otherwise. If the developed nations were allowed to emit all that pollution, why can't the developing nations do the same? When ultraviolet rays in sunlight shine on glass, resonance
occurs as the wave builds and maintains a large amplitude of electron vibration, just as pushing someone at the resonant frequency on a swing builds a large amplitude. Things in motion remain in motion if no unbalanced forces are acting upon them. To get water to form a supercritical fluid, however, requires pressures in excess of 217 atm and a
       erature of 374°C. FYI Each of us needs a knowledge filter to tell us the difference between what is true and what only pretends to be true. Delta An accumulation of sediments, commonly forming a triangular or fan-shaped plain, deposited where a stream flows into a standing body of water. If air resistance can be neglected, at what speed does it
return to its initial level? The strength of an electromagnet can be increased simply by increasing the current through the coil. Ethane has a boiling point of - 88°C, making it a gas at room temperature, and it does not dissolve in water very well. So the evidence for dark matter is strong. This stretches the Moon out slightly toward a football shape.
You hold an apple over your head. (bottom) NASA Pearson Education/Pearson Science (baseball, Earth) Shutterstock (a) National Institute of Standards and Technology (b, c) IBM Corporate Archives (a) Geoff Brightling/Dorling Kindersley Media Library (b) NOAA (top left) GIPhotoStock/ Photo Researchers, Inc. By lowering the temperature of
microorganism contaminated food, the refrigerator decreases the rate of the chemical reactions that these microorganisms depend on for growth, thereby increasing the food's shelf life. As water warms up, the hydronium-ion concentration increases and so does the hydroxide-ion concentration—and by the same amount. To provide a sense of the
current excitement, however, we also dip into some speculations, such as the possible final fate of the universe. The concept of inertia is missing. Imagine that we have a liquid with a density of 3.5 g/cm3. Nonmetallic atoms of the same type have the same electronegativities, and so their bonds are nonpolar covalent. Distinguish between evaporation
and boiling. For negative particles, the left hand can be used.) 99. Where do the bubbles form first? Tomorrow at midnight you're one Earth diameter farther from the Sun and gravitation is weaker. Practicing chemists develop a skill for balancing equations. As discussed in the previous chapter, Hubble identified and measured the distances to
numerous other galaxies. Rust is not. If the weight is equal to the buoyant force acting upward on the submerged object, it remains at any level, like a fish. In raising a 6000-N piano with a pulley system, the movers note that, for every 2 m of rope pulled down, the piano rises 0.2 m. Thus the logarithm of 100,000 is 5. Air within the cumulus cloud
moves in a cycle: Warm air rises and cool air descends. Sodium atoms and chlorine atoms, for example, bond to make the compound sodium chloride, commonly known as table salt. But gravity does act, so the ball falls below this straight-line path. Inside the cochlea, tiny hair cells convert the pulse into an electrical signal to the brain. The force of
attraction between you and Earth, however, can be measured. Hewitt 90: NASA 99: Richard Megna/Fundamental Photographs, NYC 102: ss5/ZUMA Press/NewsCom 107: Paul G. (a) Rank the voltage output of the secondaries from greatest to least. Give one location where these inversions often occur. How does the pressure exerted by a
liquid change with depth in the liquid? Uranus 63. react upon colliding, . Without a potential difference, no flow of charge occurs. First law of thermodynamics A restatement of the law of energy conservation, usually as it applies to system is equal to the system's gain in thermal energy
plus the work that it does on its surroundings. Since the rotating platform is rigid, all parts have the same rotational speed, so your friend also rotates at 20 rpm. When shell-bearing organisms die, their shells accumulate on the seafloor, where they dissolve to form a noncrystalline ooze of calcium carbonate. A rising parcel of air continues to rise as
long as it is warmer and less dense than the surrounding air. Where do you hold the folded dollar bill so that it looks the same size as the unfolded one? This is why the cannon recoils (kicks). If a variety of singly ionized atoms travel at the same speed through the magnetic field, would you expect them all to be deflected by the same amount? We each
need a knowledge filter to tell the difference between what is true and what only pretends to be true. A simpler and cleaner method that doesn't produce greenhouse gases is electrolysis— electrically splitting water into its constituent parts. What is the formula mass of nitrogen monoxide, NO, in atomic mass units? Any object, however far from Earth,
released from rest and allowed to fall to Earth only under the influence of Earth's gravity would not exceed 11.2 km/s. Can you explain why this is so? In a gas, the molecules are far apart and free from the cohesive forces that dominate their motions in the liquid and solid phases. Still another friend, Michele, has journeyed to the mountain foothills to
escape the effects of radioactivity altogether. Also, transition eyeglasses "don't work" inside a car with closed windows. Are we now saying that acceleration is instead the ratio of force to mass—that is, a g F/m? VIDEO: Polarization and 3D Viewing Nonpolarized light vibrates in all directions Horizontal and vertical components Vertical component
passes through first polarizer... Heat can be added to air CHAP TER 25 by solar radiation, by moisture condensation, or by contact with warm ground. A poorly designed transmitting antenna is also a poor receiver. The calcium and magnesium ions in hard water are more attracted to the carbonate ion with its two negative charges than they are to a
soap or detergent molecule with its single negative charge. When the layers tilt in toward the fold axis, the fold is 5 4 called a syncline. ewton's third law of motion is: Whenever one object exerts a force on a second object, the second object, the second object exerts an equal and opposite force on the first. F I G U R E 1 9 .1 8 All alkaloids are bases that react with acids
to form salts. So the mass percentage of silica is 269 kg silica * 100% = 60% 450 kg magma 39. (When small ac voltages are used in such loops, small "eddy currents" are induced in metal of any kind that passes over the loop. Aristotle made critical observations; collected specimens; and gathered, summarized, and classified almost all of the existing
knowledge of the physical world. We begin our study of Earth science by examining the ground beneath our feet—Earth's geosphere. The aluminum and oxide ions then join to form the ionic compound aluminum oxide, Al2O3. Be careful to distinguish this breaking apart from a mere change in the relative positions of a group of molecules. Another
simple machine is a pulley. (b) experiment over philosophical discussions. Notice that in this element fluorine to illustrate this principle. If the surface absorbs more energy than it emits, it is a net absorber and its temperature rises. Solution: d x 3.0 m = = = 6.0 m/s t t 0.5 s Notice how the terms of the equations guide the solution. Each year Earth
passes through the remnants of comet tails that create annual meteor showers, as indicated in Table 26.2. Meteor showers are beautiful to watch. Quantitative problems can be assigned with numerical answers and randomized values or solutions. Which box contains a liquid phase? The polar jet and the subtropical jet form in response to temperature
and pressure gradients. Parallel lines remain parallel. The force of gravity is the same on each because the masses are the same, as Newton's equation for gravitational force verifies. At a temperature of about 500°C, an object begins to emit the longest waves we can see, red light. The mold should be bigger than 6 inches because the metal will
shrink (contract) as is cools. As they get cleaned, this will increase the concentration of copper ions in solution. Why wouldn't you expect all the molecules in a gas to have the same speed? (a) Write an equation showing the distance she travels in time t. The source of oil and gas is fossilized microscopic organic matter found in buried marine
sediments. Solar distillers avoid the burning of fuels, but they require about 1 m2 of surface area to produce 4 L of fresh water per day, as shown in Figure 16.31. (b) apparent brightness. Are automobiles next, perhaps eliminating the need for mufflers? Cover the top and store in a cool place. They can penetrate fairly deeply into skin, where they have
the potential for harming or killing living cells. Aurorae, like the northern lights on Earth, are caused by charged particles from the solar wind exciting gas molecules in the upper atmosphere. Rank these compounds in order of increasing boiling point: (a) fluorine, F2; (b) hydrogen fluoride, HF; (c) hydrogen chloride, HCl. 37. How does the volume of a
N E P H Y S I CS F I G U R E 3 .1 4 Will Maynez demonstrates his air track. (b) From greatest to least, rank them by the support (normal) force the table exerts on them. Atomic mass is a measure of that the universe consisted
of an island of millions of stars nestled within a vast sea of emptiness. What was Einstein's "greatest blunder of his life"? All these ellipses have the center of Earth as one focus. Weather resulting from air masses in contact depends on the conditions of their source regions. That's why electric guitars use steel strings. The largest ellipticals are about 5
times as large as our galaxy, and the smallest are 1/100 as large. As water freezes and expands in cracks, the rock splits and breaks apart. Buyer beware! Humans are very good at denial, which may explain why pseudoscience is such a thriving enterprise. What happens to the brightness of light emitted by a lightbulb when the current in the filament
increases? Does the ozone pollution from automobiles help alleviate the ozone hole over the South Pole? Is she being reasonable? Then you sweep your arm around, making an angle of about 42^{\circ} to the wall. +--+--+ Ethanol Ethanol and water - Water C H A P T E R 16 solubility in water by noting that the only electrical attractions that occur
between oxygen molecules and water molecules are relatively weak dipole-induced dipole attractions. To make it to the top of the fractionating column, a substance must remain in the gaseous phase. In the final days of his life, at the urging of close friends, he sent his manuscript, De Revolutionibus Orbium Coelestium,** to the printer. ... By analogy,
consider a cruise ship with only 10 passengers. The apparent wetness of the road is not a reflection of skylight through the warmer and less-dense air near the road surface. You'd see the glass as a circle. Evaporation F I G U R E 7. The moving ball can then hit something and push it, doing work on what it hits. 412
PARTTWOCHEMISTRYFIGURE 16.25 (a) Sodium carbonate is added to many detergents as a water-softening agent. An electron must therefore be moving in order to have wave properties. No. Obsidian, though it is naturally formed and has a specific range of chemical compositions, is a type of glass—it is amorphous and so does not have a
crystalline structure. They reflect only part of the light that is incident upon them, the part that provides their color. FIGURE 8.2 INTERACTIVE FIGURE 8.2 INT
Bangladesh, for example, are made very deep so as to avoid the pathogens that run rampant in the drinking water supplies of many municipalities. This makes it more difficult for a gaseous solute to remain in solution because the solute molecules are
ejected by the high-energy solvent molecules. Will the color of light your friend receives be the same color you send? The new concentration of hydronium ions after the addition of 500 mL of water, therefore, is 0.05 M. A star should orbit faster, but it doesn't, which is evidence that our galaxy is surrounded by a massive halo we cannot detect with our
telescopes. An electric dryer connected to a 120-V source draws 8.4 A of current. Lethal doses of radiation begin at 500 rems. Mole The very large number 6.02 * 1023; usually used in reference to the number of atoms, ions, or molecules in a macroscopic amount of a material. Giant stars above main-sequence stars on the H-R
diagram. Rank these properties as to how much they are affected by chemical bonding: (a) color, (b) density, (c) hardness, (d) cleavage. Made up of atoms and molecules, Earth's elements combine to make minerals, which are formed by the process of crystallization from either magma or water solutions. And at convergent boundaries, they tend to be
moderate to very strong. Show that 300 cal = 1257 J, the same quantity of thermal energy in different units. (For the answer, after you have given this some thought see Appendix B, "More About Vectors.") C H A P T E R 11 REVIEW 287 For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S
(KNOWLEDGE) Additive primary colors The three colors—red, green, and blue—that, when mixed in certain proportions, can produce any color in the spectrum. Analysis of tracks bent by a strong external magnetic field showed that when an alpha particle collided with a nitrogen atom, a proton bounced out and the heavy atom recoiled a short
distance. This volume of gas could be compressed to a much smaller volume, as it is in the experimental buses in Vancouver. Nitrogen, N2 Polar Covalent? The International Space Station (ISS), shown in Figure 4.11, provides a weightless environment.
(d) take equivalent forms. This downward force is transmitted to the pedals. 74 PARTONE PHYSICS LEARNING OBJECTIVE Specify the relationship between work and kinetic energy. Standing wave A stationary wave pattern formed in a medium when two sets of identical waves pass through the medium in opposite directions. The scientific
unit of force is the newton, abbreviated N, which we'll use in this book. Faraday and Henry both discovered electromagnetic induction—that electric current could be produced in a wire simply by moving a magnet into or out of a coil of wire (Figure 9.22). (At the surface of the body, d would simply be the radius of the body.) For a bit more
mathematical insight, compare this formula with the one for orbital speed in the footnote on page 106. Slope downward- Speed increases Slope upward- Speed i
body, and d is the distance from its center. hink of the air molecules in a room as tiny randomly moving Ping-Pong balls. The blue, green, and red images of the flash were produced by a diffraction grating held over the camera lens when the photo was taken. Rocks with low silica have a high melting point, and rocks with high silica have a low melting
point. A common misconception is that satellites orbiting at high altitudes are free from gravity. Acid rain pouring into these regions is often neutralized by the calcium carbonate before any damage is done. How long will it take for this isotope to decay to about one-half of its original amount? A star's mass determines the stages a star will go through
from birth to death. Interestingly, if the Kuiper belt were more dense with material, then these dwarf planets could have served as cores for additional jovian planets. It is ever so slightly different from the rainbow seen by a person nearby. Relate what you observe to the carbon-carbon double bond. Both radio waves and light waves are
electromagnetic waves that originate in the vibrations of electrons. It is likely that sea level will rise in the future, as it has in the past. The weather is best described using a conceptual model like the one shown F I G U R E 1 2 .1 9 (a) Scanning probe microscopic imagery. As defined earlier,
the solvent is the component present in the largest amount, but what do we mean by amount? The key factor is discharge. The airflow that sets up in the eye forms a positive feedback loop. They allow students to apply the problem-solving techniques featured in the Figuring Physical Science boxed features appearing in many chapters. Your belief that
your hands are the same size is so strong that you likely overrule this visual information. The first step most public utilities take to produce potable water from natural sources is to remove any dirt particles or pathogens, such as bacteria. To find the mass percentage of silica in olivine, we divide the formula mass of silica (SiO2), which is 60.0 amu, by
the formula mass of olivine, MgFeSiO4, which is 172 amu. Nonetheless, consider it a worthy endeavor and healthy habit to get to know yourself in such a fashion. The market is enormous for therapeutic magnets and other such fruits of unreason. Rank these quantities from greatest to least: (a) gravitational force, (b) speed, (c) momentum, A E X E R
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C I S E S (SYNTHESIS) 62. And, of course, the reverse is true: you inhale atoms that were once part of everyone who has ever lived. CHAPTER 3 3.4 Energy and Work 13. CHECKPOINT Velocity is "directed" speed. Vibrations made up of compressions and rarefactions spread from the tuning fork throughout the air, and a sound wave is produced. We

```
can illustrate the relationship between molecular collisions and reaction of gaseous nitrogen and gaseous nitrogen and gaseous nitrogen monoxide, as shown in Figure 17.7. F I G U R E 17. Buoyant force remains the same. As discussed in Chapter 13, the atoms originated from the nuclear fusion of ancient stars
FIGURE 14.2 Most of the material items in any modern house are shaped by some human-devised chemical process. To some cultures, the constellations honored great heroes, such as Hercules and Orion; to yet others, they served as navigational aids for
travelers and sailors. The Greeks, for example, included the stars of the Big Dipper in a larger group of stars that outlined a bear. Chemical change? Why do you agree or disagree? Static charge is a danger in many industries today—not because of explosions, but because delicate electronic circuits may be destroyed by static charges. Hubble studied
the spectra of light coming from distant galaxies and measured the degree to which that light was shifted toward the red. This happens in a cyclic fashion to produce continuous rotation, which has been used to run clocks, operate gadgets, and lift heavy loads. Saturated solution A solution containing the maximum amount of solute that will dissolve in
its solvent. CHAPTER 26 1. The readings on both scales add up to your weight. 60 PARTONEPHYSICSREADINEST (RAT) If you have a good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. To NEPHYSICSREADINEST.
that iron boats don't sink in water or that helium balloons don't sink from the sky? When light is incident on matter, some of the electrons in the matter are forced into vibration. The closer the foci are to each other, the closer the ellipse is to a circle. During the day, warm air above the land rises, and cooler air over the water moves in to replace it.
The amount of voltage induced depends on how fast the magnetic field lines are entering or leaving the coil. Examples of pseudoscience abound. This can be seen by waves encountering a floating leaf. If the meteoroid is large enough, it may survive to reach the surface, where it is called a meteorite. A functional group is defined as a combination of
atoms that behave as a unit. As the air cools, the saturation vapor pressure drops and the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate as much water vapor as when the air cannot accommodate accommodate as when the air cannot accommodate accommodate accommodate accomm
+1 1836 1.673 * 10-27 0 1841 1.675 * 10-27 Particle Nucleons b Neutron Actual Mass* (kg) 9.11 * 10-31** * Not measured directly but calculated from experimental data. This reduces the pressure in the tube, where it is carried away by the stream of air. • Also in the
design, appearing beneath each section head is another new feature, which we call an Explain This question. Assume the galaxy is a circle whose area can be found by the equation area = pr 2. The factors that influence bond strength influence bond
well as the now firmly established idea that gravity is best viewed not as a force, but as a curvature of spacetime. Conceptual physical science / Paul G. Similarly, although small amounts of fluoride protect against tooth decay, larger amounts can cause your teeth to mottle. A third well-known alcohol is isopropyl alcohol, also called 2-propanol. Every
atom is therefore a "clock," and a slowing down of such atomic vibrations indicates the slowing down of such atomic clocks. In summer, the opposite occurs. It speaks of the quantity of energy. stitute for the Anthony coin in vending machines hang time.
With a higher silica content, the magma takes on a more andesitic or granitic composition. Electron waves are threedimensional, which makes them difficult to visualize, but scientists have come up with ways of visualizing them. The vibration of electrons in a material is similar to the vibrations of ringing bells and tuning forks. How does having a high
melting point translate to crystallizing first? Which can react with the most oxygen molecules to produce the most energy? This separation of light into colors arranged by frequency is called dispersion (Figure 11.44). There is no contradiction because the best results for each are quite different. How 18 g H2O (2 moles H2O)a b = 36 g H2O many
grams of oxygen, O2, are needed 1 mole H2O for this reaction? He set a gasket made of a ring of leather soaked in oil and wax between them to make an airtight joint. Show CHAPTER 6 that for an increase in temperature of 20°C the bridge would be nearly 0.3 m longer. Now if the weightlifter drops the barbell, gravity does work as the barbell is
 pulled down, increasing its kinetic energy. When this acid is dissolved in water, only a small portion of the acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds are broken (the C i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds are broken (the C i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds are broken (the C i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs as the polar O i H bonds of acetic acid molecules are converted to ions, a process that occurs are converted to ions, a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions, and a process that occurs are converted to ions are converted to ions.
periodic table, shown in Figure 12.5. As you can see from the periodic table, each element's name. In any case the boat reaches its terminal speed when opposing forces cancel the force of wind impact. (b) twice as much. (b) the night sky faces in opposite directions in
summer and winter. Radiant energy emitted by Earth is called terrestrial radiation. A supernova flares up to millions of times its former brightness. (b) changes by increasing amounts. What does change, however, is Earth's phase, which takes a month to cycle from full Earth to new Earth and back to full Earth. Your skin cannot evaporate water so
easily. Between the orbits of what two planets is the asteroid belt located? Look back at Figure 20.4 and you will understand the reason for this simple division. How about a few thousand years old? (a) conceptual, physical, conceptual, physical, conceptual (d)
physical, physical, physical, physical, physical 9. So we find that integrated circuits fabricated with germanium operate faster than those Bromine is a dark orange liquid that readily vaporizes at room temperature. Ma 1 pr .0 2 0 ug. After 1040 years, all protons and neutrons will have decayed, leaving behind gamma radiation and leptons, of which the electron
is an example. A study and understanding of electricity require a stepby-step approach, because one concept is the building block for the next. Each blue bean is twice as massive as each red bean. a, c, b. You can think of inertia as another word for "laziness" (or resistance to change). 5N 10 N 0N 10 N 5N The relationship between kilograms and
pounds is that 1 kg weighs 2.2 lb at Earth's surface. A blue star is hotter than a red star. Middle Clouds form at altitudes between 2000 and 6000 m. 436 PA R T T W O CH E M I S T RY F I G U R E 17. Only a change in direction occurs. Light slows when it enters glass? Behind the front, the air is warm and the clouds scatter.
Transparent The term applied to materials through which light can pass without absorption, usually in straight lines. See Projectiles universal gravitation and, 92-93 universal gravitation and gravitation a
springs and, 594-595 water table and, 593, 594-595 Gyres, 674 H Hadeon eon, 628 Half reactions, 470 Half-life, 328-331 natural transmutation and, 329-331 I-3 Hang time, 30, 102 Hard water, 411-413 Harmonics, 255 Heat, 148 of fusion, 179 specific, 151-154 units of, 149 of vaporization, 179-180 Heat capacity, specific, 151-154 Heat death, 785-
786 Heat exchange, adiabatic processes and, 686-688 Heat transfer, 164-180 boiling and, 176-178 by conduction, 166-167 by evaporation, 178-179 melting and, 179-179 melting
355. Ordinary matter, the stuff of stars, cabbages, and kings, makes up only about 4%. W To understand torque (rhymes with dork), hold the end of a meterstick horizontally with your hand. 7 7 55. The alpha particle was absorbed in the process, transforming nitrogen to oxygen. Discounting the pressure of the atmosphere, if you swim twice as deep
in water, how much more water pressure is exerted on your ears? (b) the same momentum. Acetaldehyde won't cause you to go blind, but it does provide for some painful side effects, which people who drink too much experience as part of their "hangover." H H O H Water Phosphoric acid H H H C C H H H O Ethanol The liquid produced by
fermentation has an ethanol concentration no greater than about 12% because at this concentration the yeast cells begin to die. There is an important relationship between the percent growth per unit time % So to estimate the doubling time, the time it takes to double a quantity:† Doubling time = 70 69.3 • percent growth per unit time % So to estimate the doubling time.
for a steadily growing quantity, we simply divide the number 70 by the percentage growth rate. CHAPTER 2 Newton's First Law of Motion 2.1 EXPLAIN THIS Why isn't inertia a kind of force? We will begin by exploring the two major types of synthetic polymers used today—addition polymers and condensation polymers. In this schematic, the ionic
end of the fatty acid is shown as a circle, and the nonpolar chain is shown as a circle, and the pan. 2 The Chemist's Classification of the jar isn't in contact with the bottom of the pan. 2 The Chemist's Classification of Matter 16. The result is a temporarily uneven distribution of electrons called an induced dipole. Solution:
the distance to Proxima Centauri: 26,000 [email protected] = 6190 4.2 [email protected] So the center of our galaxy is about 6200 times as far away as the nearest star. For these three problems, consider a small, experimental air mass at 30°C that weighs 90 N. When its KE is at half its maximum value, how much PE does it possess? (a) chemical,
because of the formation of elements (b) physical, because a new material has been formed (c) chemical, because of a change in phase 7. Chemists use a superscript to the right of the atomic symbol to indicate the magnitude and sign of an ion's charge. The latter is more likely. The rotating
tires of the car push back on the road (action). A shorter time for the molecules to bump against one another results in a faster speed of sound. The wavelength of a wave is the distance from the top of the next one or, equivalently, the distance from the top of the wave. Another distinction between speed of sound.
and velocity has to do with the difference between distance, or displacement. (b) How does this number of calories compare with the number of calories compare with the number of calories required to change the same gram of 100°C steam? Let's take a moment to consider this point, looking to Figures 15.4 and 15.5 as visual guides. In order that
it is the hottest when you are ready for it, would you be wiser to add cream to it right away or just before you are ready to drink it? The ball is thrown horizontally, so the pitching speed is horizontal distance divided by time. Combustion An exothermic oxidation-reduction reaction between a nonmetallic material and molecular oxygen. Nitrogen was
essentially left behind as the dominant gas in Earth's atmosphere. Clouds don't float! They are buoyed up by an invisible conveyor belt of air. In fact, on the Moon, as long as you don't move about, Earth remains in the S-27 same place in the sky for the same reason we see only one face of the Moon. Gadomski/Photo Researchers, Inc. Solution
Humidity = 0.13 kg mass of water = = 0.018 kg/m3 volume of air 7.2 m3 SAM PLE PROBLEM 3 Solution: At 30°C, the maximum amount of water vapor in the air mass is 30 g/m3 of water vapor in the air mass is 30 g/m3 of water vapor in the air mass is 30 g/m3 of water vapor. FIGURE 5.7 The forces due to liquid pressure against a surface combine to produce a net force that is perpendicular to the surface. Stretch
rubber band between your thumbs and pluck it with your index finger. Aluminum hydroxide 3 Calcium sulfate Gelatinous aluminum hydroxide and impurities collect at bottom of basin. Would the electric potential of the test charge be the same, or would it be twice as great? During the process of mountain building, Earth's crust is severely
compressed into a mass of highly deformed rock. In accord with energy conservation, a person who takes in more energy than is expended stores what's left over as added chemical energy in the body, which in practice means more fat. The direction of heat flow is from hot to cold. In a large atom, however, the electrons find it fairly easy to do justing the process of highly deformed rock. In accord with energy conservation, a person who takes in more energy than is expended stores what's left over as added chemical energy in the body, which in practice means more fat. The direction of heat flow is from hot to cold. In a large atom, however, the electrons find it fairly easy to do justing the process of highly deformed rock.
that. 368 PA R T T W O CH E M I S T RY 15.1 LEARNING OBJECTIVE Identify paired and unpaired electrons in an electron-dot structure. Why? A friend says that changing electric and magnetic fields generate each other, and this gives rise to visible light when the frequency of change matches the frequencies of light. When their axes are at right
angles to each other? How might you modify your distiller so that it works well using only sunlight? New questions were either discarded or reworded for improved quality. As we look to quasars, therefore, we are peering into the early lives of galaxies (Figure 27.34). Then Specific discharge = hydraulic conductivity *
hydraulic gradient = 150 m/day * 0.0033333 = 0.5 m/day * 0.003333 = 0.003333 = 0.003333 = 0.003333 = 0.003333 = 0.003333 = 0.003333 = 0.003333 = 0.003333 = 0.00333 = 0.003333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.00333 = 0.003
outgassing of a brief but intense period of starburst activity occurring at the galactic core. How does the buoyant force on a fully submerged object compare with the weight of the water displaced? Lastly, we know that the path of light is bent by gravity much as it is bent by an optical lens. Increases? When you weigh yourself on a bathroom scale at
rest, the support force and your weight have the same magnitude. (a) The sample is being cooled and the material is freezing. The work that the rock does on the ground is equal to its PE before being dropped, mgh = 100 J. The solid melts. "News" of the supernova took 190,000 years to reach Earth! 27.2 The Brightness and Color of Stars EXPLAIN
THIS S How do astronomers gauge the temperature of a star? "At every crossway on the road that leads to the future, each progressive spirit is opposed by a thousand men appointed to guard the past." Mathematics and Conceptual Physical Science LEARNING OBJECTIVE Recount how mathematics contributes to success in science. We can assume
therefore, that the attractions among the submicroscopic particles in the solid phase at 25°C are stronger than they are in the gas phase. New thoughts will keep popping into your mind, but return your attention to your out-breath. Name the rock for each statement, then rank them from low to high grade: (a) foliated rock, sometimes derived from
granite (b) foliated rock, possessing excellent rock cleavage; generally used in making blackboards (c) foliated rock containing about 50% platy minerals; named according to the major minerals in the rock 42. Suppose a piano tuner hears three beats per second when listening to the combined sound from his tuning fork and the piano note being
tuned. 1 Most Materials Are Mixtures 16. A magnetic force acting on a beam of electrons can change (a) only the direction of the beam. Discuss whether or not the temperature rises. Support for Hess's theory came from paleomagnetic studies of the ocean floor. (Hint: Look at the spinning Earth from above either pole and compare it to a spinning
dodecyl benzenesulfonate CHECKPOINT What type of attractions hold soap or detergent molecules to grime? (b) When the spaceship accelerates, an occupant inside feels "gravity." F I G U R E 2 8 .1 0 To an observer inside the accelerates, an occupant inside feels "gravity." F I G U R E 2 8 .1 0 To an observer inside the accelerates, an occupant inside feels "gravity." F I G U R E 2 8 .1 0 To an observer inside the accelerations hold soap or detergent molecules to grime?
operation of the pile driver back in Figure 3.20. Every ship, submarine, or dirigible airship must be designed to displace a weight of fluid equal to its own weight. The rock travels a smooth parabolic path in time t. Suppose that water is used in a thermometer instead of mercury. (d) of the lack of contrast with moonlight. Molecule b is an amine. When
the coil contracts, the mercury rolls against the contacts and completes the circuit. So, food is cooked by converting H2O molecules into flip-flopping energy sources that impart thermal motion to surrounding food molecules. And if you replace the hanging straw with a glass test tube and rub it and another test tube with silk, the two rubbed test
tubes repel. The concept of inertia was unknown to him and others of his time. (b) they simply don't exist in the daytime part of the sky. This is shown in Figure 9.36). In which is a repeat of Figure 9.36). In which is there greater thermal energy? Unless the ships are steered to compensate for this, the greater pressure against the outer sides of the ships
forces them together. Away from the moisture, the rate of evaporation Condensation is much higher than the rate of condensation, and you feel chilly. Divergent plate boundary where lithospheric crust is formed. 718 PA R T F
O U R ASTRONOMY Why are planets round? Just as circular waves are closer together and reach an observer more frequently. (a) Use Newton's second law and show that the acceleration of the carton is F η f m (b) If the carton's mass is 4.0 kg
the applied force is 12.0 N, and the friction force is 6.0 N, show that the carton's acceleration is 1.5 m/s 2. When boiling spaghetti, is your cooking time reduced if the water is vigorously boiling instead of gently boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti, is your cooking time reduced if the water is vigorously boiling spaghetti.
chaotic motion. If you could fly to the Sun on a jet that moves at 1000 km/h, how long would it take? R P 1320 W 57. (b) light. If the rocks in the fold axis are older than those away from the axis, the fold is an anticline. Grace teams up with grandchildren Alexander Hewitt and Megan and Emily Abrams for the series of group photos on page 279. All
quasars are billions of light-years away from our galaxy. S TARSANDGALAXIES 749 Do planets also orbit other stars? To date, most astronomers find the dark matter theory to be more acceptable. So coal, made from decayed plant material, is not a mineral. (c) remains constant if flow rate is constant. (b) D, C, A = B. Raindrops form because
the condensation rate exceeds the evaporation rate. This precession would be very slight for distant planets and more pronounced for planets close to the Sun. The subtropical jet is generated as warm air is carried from the equator toward the poles, producing a sharp temperature gradient along the subtropical front. Is momentum conserved during
an elastic collision? The incident light, therefore, is reflected in all directions. Intriguing physics! CHAPTER 1 REVIEW 31 For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Acceleration The rate at which velocity changes with time; the change in velocity may be in magnitude or
direction or both, usually measured in m/s2. An interesting question often arises: if action and reaction forces are equal and opposite, why don't they cancel to zero? A transformer will step up both simultaneously—that is, a transformer cannot step up energy
and generated the great quantities of iron ores that are crucial to our industrial age. Is there any nemesis star right now within this limit ready to supernova? Is polarization a property of transverse waves, longitudinal waves, or both? These devices are commonly connected in a circuit in one of two ways: in series or in parallel. different components
can be seen Mixtures may be heterogeneous or homogeneous. They "want" to return to their original positions. Without the greenhouse effect, Earth would be a very cold place, with an average temperature about - 18°C. Petroleum, also called crude oil, is a liquid readily separated into its hydrocarbon components through a process known as
fractional distillation, shown in Figure 19.3. The crude oil is heated in a pipe still to a temperature high enough to vaporize most of the components. In this way a polymer chain is built. At the divergent boundary, the asthenosphere is very near the surface and the lithosphere is very thin.* Mid-ocean ridges mark the locations of most divergent plateau for the components.
boundaries. When they vibrate in air, they make the air molecules they touch wiggle and jiggle too, in exactly the same way, and these vibrations spread out in all directions, getting weaker, losing energy as heat, until they die out completely. 90° 32. For this reason, it is in everyone's interest to become acquainted with the basic concepts of
chemistry. 1.10 Acceleration EXPLAIN THIS Why is the word change important in describing acceleration? (b) A rough estimate of the pH of a solution can be obtained with litmus paper, which is coated with a dye that changes color with pH. (d) air expands and cools. The majority of metamorphic rocks are associated with convergent boundaries.
Some atoms link together to form larger but still incredibly small basic units of matter called molecules. Suppose that the freely falling object in the preceding exercise falls from a rest position and is equipped with an odometer. The unsaturated fatty acids are gaining hydrogen atoms, so they are being reduced. This became the banded iron
formations. If dark matter is affected by gravity, might there be lots of it surrounding us here on the surface of the Earth? This was shown in Figure 11.6. The oxides and sulfides make up the majority of ore minerals. (c) boxer's attitude. The
other end (not shown) is anchored. The weight of the book squeezes downward on the atoms, and they squeeze upward on the book. VIDEO: Archimedes' Principle 1. What keeps a main-sequence star from collapsing? (b) gravitational field. 8 Machines 3. Otherwise the satellite would go in a straight line and leave Earth. Phosphate ions, PO4 3-, were
once added to detergents to assist in cleaning. When light shines on metal and sets these free electrons into vibration, their energy does not "spring" from atom to atom in the material. Saturn, with a greater spin, noticeably departs from a purely spherical shape. Now, if you overlap your hands slightly and view them with one eye closed, you'll see the
nearer hand as clearly bigger. Study Exercise 76 before attempting to balance both the atoms and charges of this chemical equation: Fe3 + + I - h Fe2 + + I2 78. Thus, the hypothesis of continental drift was revived, but a mechanism to explain how the movement occurred was still lacking. The force of the bus on the bug splatters it all over the
windshield. Thus, in a conveyor-belt fashion, new lithosphere forms at a spreading center and older lithosphere is pushed out from the ridge crest, eventually to be recycled back into the mantle at a deep ocean trench (Figure 21.18). Isaac Newton's answer to this was that neither force has to be identified as "exerter" or "receiver," and he concluded
that both objects must be treated equally. Given that 92.58% of all lithium atoms found in nature are lithium-6, show that the atomic mass of lithium, Li (atomic number 3), is 6.941 amu. A change in atmospheric stability can cause this change. Half-life The time required for half the atoms in a sample of a radioactive isotope to
decay. For example, LEARNING OBJECTIVE Describe the structure of the atomic nucleus and how the atomic
bent by the Sun's distortion of spacetime. Protons also repel other protons by the electric force. In the top-down approach, nanostructures are carved out of larger materials. Nucleon Any subatomic particle found in the atomic nucleus; another name for either a proton or a neutron. An example is acetone. We cannot see, smell, or feel most forms of
energy. 0 2 2009 20 13 Nov. Using 300,000,000 km for the diameter of Earth's orbit, calculate the speed of light based on Roemer's 1300-s estimate. This makes up a dipole, an extension of electriccharge polarization, which was discussed in Chapter 8. Watch for fuel cell-powered vehicles in the future! FIGURE 3.33 Energy transitions. 7.4 Newton's
Law of Cooling 13. Subcritical pieces of uranium FIGURE 13.25 Simplified diagram of a uranium fission bomb. Plants and all other organisms that live on Earth's surface benefit from this ozone because of its ability to shade the planet's surface benefit from this ozone because of its ability to shade the planet's surface benefit from this ozone because of its ability to shade the planet's surface from ultraviolet light. Parallel Circuits and Overloading Electricity is usually fed into a home by way of two
wires called lines. Part of the Slinky compresses and part of it stretches as the waves travel back and forth in the direction of propagation. Recall that electrons are negative, and so they are repelled by the negative charge in the right container. Efficiency = MOMENTUM AN D ENERGY
Building a perpetualmotion machine (a device that can do work without energy input) is a no-no. One such area is the New Madrid seismic zone in the *A thrust fault plane. Whether they result from collisions, absorption of electromagnetic radiation, or both, broken
bonds are a necessary first step in most chemical reactions. Even small pumps, or small pumps,
seen by day as well as by night. If you shatter the mineral calcite with a hammer, the surfaces where it broke are smooth and flat. This explains, in part, why potassium chloride crystals are weaker (softer) than sodium chloride crystals are weaker (softer) than sodium chloride crystals.
contact explains how a karate expert can split a stack of bricks with the blow of her bare hand (Figure 3.7). The atoms that are closer to the lower left corner of the periodic table bear the positive charge: hydrogen, bromine, carbon, neither! 61. Who is the ultimate expert at nanotechnology? The driver is concerned with the average speed for the trip
(b) remains unchanged. (a) An increase in the number of carbon atoms per molecule also means an increase in the density of the hydrocarbon. I f you look to the upper right of the periodic table, you will find one of the most common oxidizing agents—oxygen. 800 N? Because fish hear mainly low frequencies, they are not alerted to the fact that they
are being hunted. Wood has a very low conductivity. The photon energy most often corresponds to the frequency of red light, which is why most LEDs emit red light. The distance the piling penetrates into the ground multiplied by the average force of impact is almost equal to the initial potential energy of the ram. J When a common automobile
©t, and in Chapter 2 we learned that the cause of acceleration involves net force, where a = F/m. It doesn't matter how fast the opportunity to apply the concepts of physical science to real-life situations, such as whether a cup of hot coffee served to you in
a restaurant cools faster when cream is added promptly or a few minutes later. Place a coin on top of a sheet of paper on a desk or table. Ancillary Materials C onceptual Physical Science is now available with MasteringPhysics—a homework, tutorial, and assessment system based on years of research into how students work problems and precisely
increased KE, and thereby warm the liquid. The flow ceases when the difference in pressure ceases. How about a neutral solution? The polar jet results from a temperature gradient at the polar front, where cool polar air meets warm subtropical air. Nonetheless, gravity does in fact behave as though it is a force, so even scientists who are comfortable
with general relativity use S-29 this term in their discussions of gravity.) 71. As a result, little energy is required to separate ether molecules from one another. If it's a metal door, the charged balloon induces an opposite charge on the door. That is, all the forces that act on it balance to zero. Physical property Any physical attribute of a substance,
reflection. In solution, a strong base allows the flow of a large electric current, and a weak base allows the flow of a small electric current. Compare your octaves with those of friends. 5 Climate Change and the Greenhouse Effect 7. When evaporation occurs in a dish of water, the molecules left behind in the water (a) are less energetic. Many modern
mountains are actually the exposed batholith cores of larger mountains that eroded away long ago. This multiplication is done at the expense of (a) energy, which is divided by 100. If we compare our train to wave motion, where wavelength = 3 Hz * 10 m = 30 m/s 2.
The equations are guides to thinking that * From Count Maurice Maeterlinck's "Our Social Duty." PROLOGUE T H E N AT U R E O F S CI E N CE show the connections between concepts in nature. FIGURE 8.25 Resistors. Instead, energy is merely converted from one form to another. Once this mixture has frozen, it will be your "rock." Step 2. Where
you are on a staircase is restricted to where the steps are—you cannot stand Electron High potential energy FIGURE 12.25 An electron is lifted away from the nucleus as the atom it is in absorbs a photon of light. Similarly, the second and third shells each have the capacity for eighted away from the nucleus as the atom it is in absorbs a photon of light.
electrons, so eight elements are found in both the second and the third periods. The sound that reaches our ears throbs between maximum and minimum loudness and produces a tremolo effect. 2 M E T E O R S H O W E R DATA Shower Name Radiant* Dates Quadrantids Eta Aquarids Perseids Orionids Geminids Perseids Orionids Orionids Geminids Perseids Orionids Orionids Orionidas 
different from the momentum it possesses with respect to another moving object. Ice Brass Iron A practical application of a bimetallic strip wrapped into a coil is the thermostat (Figure 6.18). The horizontal dashed line at the top would be its path if there were no gravity. Forecasting beyond seven days is considered
long-range, and the predictions in such forecasts are in terms of conditions that are expected to be above or below normal. Lastly, numbers are placed in front of the reactants or products to show the ratio in which they either combine or form. Maxwell asked her how she would feel if she knew that she was walking with the only person in the world
who knew what starlight really was. Forces occur in pairs: one is an action and the other is a reaction, which together constitute the interaction between one object and the other. When you tune your radio, you are similarly adjusting the natural frequency of the electronics in the device to match one of the many surrounding signals. From the
definition, power = energy per unit time, it follows that energy = power * time. (b) high mass. A carbon atom in a saturated hydrocarbon is bonded to four atoms. (a) heat death (b) Big Rip (c) eternal inflation (d) all of the above Answers to RAT 1. What is a falling star? Hewitt. Some rocks are aggregates of fossil shell fragments, solid organic matter
or any combination of two or three of these components. What are constellations? (e) blue giant. Another interesting exception is hydrogen, H, which takes on the properties of a liquid metal only at very high pressures (Figure 12.10). This is known as the inversesquare law. If such an infrastructure were in place, the wind energy of the Great Plains of
the United States would be sufficient to supply the electrical needs of the entire country. 13.2 The Strong Nuclear Force EXPLAIN THIS A Why are larger nuclei less stable than smaller nuclei? Coal is a solid material that contains many large, complex hydrocarbon molecules. Reckless Rick driving along the road at 90 km/h bumps into Hapless Harry
directly in front of him who is driving at 88 km/h. An ammeter is placed in different locations, as shown. The force of the atmosphere at sea level against the outside of a [email protected] store window is about 1 million N. The finding that Burl's rope had a higher pitch seemed reasonable because his rope supported more of the load. 2 The mass of
one Ping-Pong ball is 2 g. Velcro, watch out! FIGURE 15. 14.7 The Advent of Nanotechnology 30. Rather, half-life is a function of the stability of the nucleus. (b) A horizontally plane-polarized wave from a charge vibrating horizontally. For example, 1 mole of carbon dioxide
(44 g). This loop is affixed to a mechanical vibrator that can be adjusted to create waves of different Mechanical vibrator One w a vel en g (b) Wavelength is self-reinforcing. Chemical sedimentary Rocks Recall that chemical sediments, and in turn chemical rocks, form by the precipitation of minerals from water solutions. Chemical bond strength
greatly influences certain physical properties of a mineral. Only the total current in the battery changes. S-waves cannot travel through liquids. According to the cosmic background radiation, what is the average temperature of the universe today? Green / Alamy (left
right) Paul G. Global combustion of coal produces about 13,000 tons of radioactive substances; nuclear plants produce about 10,000 tons. 194 PARTONEPHYSICS (a) (b) FIGURE8.13 (a) The PE (gravitational potential energy) of a mass held in a gravitational field. How many grams is this? A neutral solution is also formed when equal
quantities of acid and base are combined, which explains why acids and bases are said to neutralize each other. CHAPTER 10 1. In fresh water, this reaction is reversible, and the carbon dioxide is released back into the atmosphere. A sine wave is the simplest of waves, having a single frequency, as shown in Figures 10.1 and 10.44. Foliation is a
prominent visual feature of regionally metamorphosed rocks, and it is very different from the layering seen in sedimentary rock. The remaining hydrogen and hydroxide ions join to form water. These concepts are revisited in Exercise 37 at the end of the chapter. Electrolysis The use of electric energy to produce chemical change. Under what
conditions does orographic precipitation occur? 8 Doppler Effect 10. In terms of impulse and momentum, when a boxer is being hit, why is it important that he or she move away from the punch? When a hypothesis has been tested over and over again and has not been contradicted, it may become known as a law or principle. Difficulty in solving
today's problems results more from social inertia than from failing technology. Neither force exists without the other. Both the half and the entire candy bar have the same density. A station at 960 kHz on the AM radio dial, for example, broadcasts radio waves that have a frequency of 960,000 vibrations per second. This method of separating a solid-
liquid mixture is called filtration, and it is a common technique used by chemists. 2 4 The exchange of molecules at the interface between liquid and gaseous water. Only you can answer the last question! 1.3 Mass—A Measure of Inertia EXPLAIN THIS Why is your mass, but not your weight, the same on Earth as LEARNING OBJECTIVE Describe and
distinguish between mass and weight. What did Wegener's contemporaries evidently not know about the mantle? Hind sight is 20-20. By Newton's laws, we would say that we escaped the Sun's now weaker gravitational pull. The slash symbol (/) is read as "per" and means "divided by." In physics the preferred unit of speed is meters per second (m/s)
(Assume that the specific heat capacity of steel is 450 J/kg # °C.) 38. In this sense, you don't "own" the atoms that make up your body—you are simply their present caretaker. The term cyclone refers to counterclockwise rotation, in the Northern Hemisphere, around a low-pressure center. Use a nonmetal container, such as a ceramic or plastic bowl.
 Rank the following organic molecules in order of increasing solubility in water: 33. It burns clean, producing only energy and water vapor. Evaporation is a phase change at the surface of a liquid; boiling is a phase change that occurs throughout a liquid, producing bubbles. The collision-coalescence process needs to occur: (1) condensation nuclei, (2)
water vapor to cloud droplets, (3) updrafts, (4) droplet bombardment, and (5) droplet growth. Suppose that half of the heat generated goes into warming the ball. Even in this weightless condition, however, a gravitational force is still acting on you, causing your downward acceleration. Before falling into the black hole, the doomed mass forms a
rapidly spinning disk, called an accretion disk, around the equator of the black hole. Which produces more energy: the fission of a single uranium nucleus or the fusing of a pair of deuterium nucleus or the fusing up of ash, cinders, and rocks that have been explosively erupted from a single vent to form a symmetrical, steep-sided
cone. Over time, these particles are deposited on the inner surface of the glass, causing the bulb to blacken. Eight hours later, the detector registers 5 counts per second. A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 27. A magnetic force acts most strongly on a current-carrying wire when the wire (a) carries a very large current. The
advancing wall of clouds at the front develops into thunderstorms with heavy showers and gusty winds. Because the Sun is a fluid rather than a solid, different latitudes of the Sun spin at different latitudes of the Sun spin at different latitudes of the Sun spin at different latitudes of the Sun is a fluid rather than a solid, different latitudes of the Sun spin at 
monitors and flat-screen televisions. The chemical structure of detergent molecules in that both possess a polar head attached to a nonpolar tail. Rocks respond to these stresses in three different ways. Cosmological redshift The elongation of light waves due to the expansion of space. (b) ejected air. Likewise, have
respect for all that we will surely be learning in the future. Then consider the following: A certain device in a 120-V circuit has a current rating of 20 A. (d) nothing 5. If you have one molecule of TiO2, how many molecules of O2 does it contain? Does the force of friction make up the reaction force to your push? About 80% of the world's volcanoes are
in the region known as the "Ring of Fire." 31. Rank the compounds in order of increasing symmetry: (a) CH4, (b) NH3, (c) H2O. 7 Interestingly, the seven stars of the Big Dipper are at varying distances from Earth. When the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite, the melting point of the oxide drops to a more reasonable 980°C. The saturated zone is mixed with the mineral cryolite is mixed with the m
where pore spaces are filled (saturated) with water. When the cans are left stationary for several days, they become magnetized by induction, aligning with Earth's magnetic field. A rocket coasts in an elliptical orbit around Earth. Is this an example of oxidation or reduction? * Unlike most concepts in physics, friction is a very complicated
phenomenon. A step-up transformer multiplies voltage in the secondary; a stepdown transformer does the opposite—decreases voltage in the secondary. Hence there is no buildup of energy in Earth's interior. The solar energy is more readily dispersed by the water molecules in the gaseous phase. When the pendulum bob swings by the point that
 marks half its maximum height, it has half its maximum KE, and its PE is halfway between its minimum and maximum values. For classification and identification, metamorphic rocks can be divided into two groups: foliated and nonfoliated. More than 300 million years ago, a huge continental ice sheet covered parts of South America, southern Africa,
India, and southern Australia Continental shelf (Figure 21.13). Areas of regional metamorphism are the hunting grounds of gem prospectors, because the heat and pressure that accompany these changes can produce beautiful minerals. Is the fur charged? CHAPTER 6 Heat The thermal energy that flows from a substance of higher temperature to a
upward against an object immersed in air is greater than the pressure above pushing down. Notice that the vertical distance that each stone falls beneath the idealized straight-line path is the same for equal times. As the air cools to its dew point, water vapor condenses on the sunglasses. 124. When you get a bit ahead in your studies, cut classes
some afternoon and visit your local pool or billiards parlor and bone up on momentum conservation. 1 The Geosphere Is Made Up of Rocks and Minerals 20. 7.7 Boiling 23. Love waves move in a side-to-side, whiplike motion. As opposing air masses slide past one another, the air starts to spin—a cyclone. (You won't be able to do this indoors unless you
(b) Vinegar contains acetic acid, C2H4O2, and can be used to preserve foods. Why does an inflated beach ball pushed beneath the surface of water swiftly shoot above the water surface when released? Then turn the cans upside down and note how many days it takes for the poles to reverse themselves. The interior of the coin is pure copper. Tie a
rubber tube, a spring, or a rope to a fixed support and shake it to produce standing waves. 3 2 The fuse shown in Figure 8.33 is constructed with a wire ribbon that heats Circuit diagram for appliances conup and melts at a given current. With no air resistance, the cannonball will travel a horizontal distance of 100 m [d = vxt = (20 m/s)(5 s) = 100 m]
What is the shape of the orbit when the velocity of the satellite is everywhere perpendicular to the force of gravity? The Rocky Mountains on the western edge of Denver play a similar role in trapping smog beneath a temperature inversion. Their combined effect produces the trajectories of projectiles. Reconsider the rope analogy of Figure 15.26.
Although numerous theories abound about the fundamental nature of dark matter, no dark matter particles have been detected. For example, a commuter who travels 10 kilometers to work and back travels 20 kilometers, but has "gone" nowhere. Bernoulli's principle refers to the internal pressure changes in a fluid, not to pressures the fluid may
exert when it interacts with objects in the fluid. Mixing Colored Lights Visible light Frequency All the colors added together produce white. We see these objects as comets, which are characterized by their long and sometimes quite brilliant tails. universe is only about 14 billion years old. It needs no word or symbol for "fish," for example, but can
communicate an image of the real thing—perhaps with emphasis highlighted by selective filtering, as we similarly communicate a musical concert to others via various means of sound reproduction. Another former student, Helen Yan, now an orbit analyst for Lockheed Martin Corporation and part-time physics instructor at City College of San
Francisco, poses with a black-and-white box on page 171. Why are some minerals harder than others? Why is rain or snow called precipitation? When the more abundant isotope U-238 absorbs neutrons created by fission of U-235, the U-238 typically does not undergo fission. (a) They are sources of naturally occurring gold. Water is different. In
circuits of metal wires, electrons make up the flow of charge. According to Boyle's law, the pressure increases to three times its original pressure. A good absorber of radiant energy reflects very little of it, including visible light. LEARNING OBJECTIVE Relate electric field strength with patterns of electrical lines of force. What's
New to This Edition C onceptual Physical Science now comes with a powerful media package including MasteringPhysics®, the most widely used, educationally proven, and technologically advanced tutorial and homework system available. your room? A tone that has twice the frequency of the fundamental is the second harmonic, a tone with three
times the fundamental frequency is the third harmonic, and so on (Figure 10.42).* The variety of partial tones gives a musical note its characteristic quality. Crystal size is greatest at the contact and decreases with increasing distance from that point. Put this "rock" in a bowl in the refrigerator overnight, and then examine the contents of the bowl the
Secondary 9.9 The Transformer—Boosting or Lowering Voltage EXPLAIN THIS Which of these can a transformer increase: voltage, current, energy? On the continents, the most common igneous rocks are granite and andesite. Rotating loop Magnet A motor and a generator are actually the same device, with input and output reversed. Hewitt (bottom
left, right) John Suchocki/Paul G. In a similar way, the shift of Earth's mass distribution resulted in a change of speed in Earth's spin. 8.5 Voltage Sources EXPLAIN THIS W Why is an electric battery often called an electric pump? A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 26. (The usual classroom procedure is to release the ball from
the nose at rest. A number of approaches have been proposed to tap into the power or fuel sources the body already provides. Rank the nuclear fuels in order of being consumed, from first to last: (a) carbon, (b) helium, and (c) hydrogen. Insulation simply slows down the rate at which thermal energy flows. Subsequent chemistry chapters follow a
traditional approach covering chemical changes, bonding, molecular interactions, and the formation of mixtures. 3 To have equal numbers of carbon atoms and oxygen molecules requires measuring out 38 as much carbon as oxygen. The Sun would be invisible. Nova An event in which a white dwarf suddenly brightens and appears as a "new" star. c,
7. In general, minerals that have strong bonds between planar (flat) crystal surfaces show poor cleavage, whereas those with weak bonds along planar surfaces show more distinct cleavage. Refraction, light The bending of an oblique ray of light when it passes from one transparent medium to another. An electric field is nature's storehouse of electric
energy. Rinse the sand several times with fresh water to make sure all the salt has been removed. Your instructor may also share with you his or her favorite methods. When unstable rising air is moist, billowy and towering clouds develop. So Newton's law of gravitation for masses is similar to Coulomb's law for electrically charged bodies. This
scenario, in which observable universes are spawned on a perpetual basis, is known as eternal inflation. Sulfuric acid eventually corrodes metal, paint, and other exposed substances. On the left we notice equally timed sequential positions of the ball without the effect of
gravity. Both sound and light obey the same law of reflection. This explains how fire-walking coauthor John Suchocki can walk barefoot on red-hot wood coals without burning his feet (as shown in the chapter-opener photo). If you stand on a bathroom scale in a moving elevator, you'll find variations in your weight. Hold some room-temperature water
with little deflection. The electric signal, however, travels at nearly the speed of light. This is a step-down transformer. Solubility The ability of a solute to dissolve in a given solvent. Isoprene (2-methyl-1,3-butadiene) beta-Carotene D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 68. Most of the world speaks of low-joule foods and drinks.
Archimedes' principle applies to air just as it does for water: An object surrounded by air is buoyed up by a force equal to the weight of the same soda when carbonated. (b) reaches its equilibrium level and then begins to sink. 362 PA R T T W O CH E M I S T RY Scanning
probe microscope A tool of nanotechnology that detects and characterizes the surface atoms of materials by way of an ultrathin probe tip, which is detected by laser light as it is mechanically dragged over the surface. H \le OHHCCHM Water (acid) HHCCMM Water (a
group of naturally occurring complex molecules that are alkaline because they contain nitrogen atoms are often called alkaloids. A pair of forces is involved: your push on the wall and the wall's push back on you.* In Figure 2.15, we see a boxer's fist hitting a massive punching bag. The risks to all members of society need consideration when public
policies are decided. 278 PARTONEPHYSICSFIGURE11.11, a spring in the scale stretches until the scale reads 2 lb. * As a point of reference for physicists reading this text, these shells of orbitals are grouped by similar energy levels rather than by
principal quantum number. The outcome was a trial in which he was forced to renounce his discoveries. 5 Work- Energy Theorem 3. Which medications should be sold to the general public over the counter and how should they be labeled? Hahn Neutron Collision wrote of this news to his former colleague Lise Meitner, who
had fled from Nazi Germany to Sweden because of her Jewish Nucleus ancestry. The main reason they do not meet full planet status is that they have yet to accrete all the material in their orbital paths. Instructors using MasteringPhysics can assign content that is tied to these book-specific learning outcomes. Both have the same acceleration because
both gain the same amount of speed in the same time. W hen all the bonds in a molecule as a whole is also nonpolar—as is the case with H2, O2, and N2. In a cooking pot make a hot saturated solution of sugar in water. Nota (ESA/STScI) et al., ESA, NASA 758: (top, bottom) NASA 759: (top) NASA's Goddard Space Flight
Center 759: (bottom) NASA 760: NASA 760: NASA 761: (top, bottom) NASA 762: (top, bottom) NASA 763: (to
Figure 12.8 for the answer.) Recognize that 98.89% and 0.0111, respectively. Rarefaction A rarefied region, or a region of lessened pressure, of the medium through which a longitudinal wave travels. When Tim pushes the wire between the poles of the magnet, the galvanometer registers a pulse. If the
            has 500 turns, show that the secondary should have 25 turns. So dipoles that FIGURE 15.25 are of equal strength but pull in opposite directions in a molecule as a whole is nonpolar. In this case Earth interacts with the falling
of gravity. Assuming the illustrations depict a sunset, within 24 hours of when this scene is depicted will the Moon appear to be farther from or closer to the Sun? (The induction of an electric field.) Voltage induced \( \varrho\) number of loops * change in magnetic field time
Fault A fracture along which movement of rock on one side relative to rock on the ocean floor across the North Pacific Ocean. Both exothermic and endothermic reactions, illustrated in Figure 17.17, can be understood through the concept of bond energy. Why can't humans hear them? The
cooling system of an automobile is a better analogy to an electric circuit because it is a closed system and it contains a pump, analogous to the battery or S-9 other voltage source in a circuit. In terms of thermal expansion, why is it important that a lock and its key be made of the same or similar materials? (See Think and Solve 36.) 32. This refraction
at the second surface, like that in a prism, increases the dispersion already produced at the first surface.* F I G U R E 11. 28. As shown in Figure 15.15, a fluorine atom, F +9 +9 Fluorine atom can obtain an additional electron Covalent bond Bond forming +9 +9 Fluorine atom, F +9 +9 Fluorine atom, F +9 +9 Fluorine atom can obtain an additional electron Covalent bond Bond forming +9 +9 Fluorine atom, F +9 +9 F
M O L E CU L E S AT T R AC T 377 by holding onto the unpaired valence electron of another fluorine atom. At about 1500°C, all the different waves to which the eye is sensitive are emitted and we see an object as "white hot." A blue-hot star is hotter than a white-hot star, and a red-hot star is less hot. If we push an object at constant velocity, how do
we know how much friction acts on the object compared to our pushing force? DISCUSSIONOUESTIONS (EVALUATION) 19. Emission of a beta particle increases the atomic number by 1. The gap in the ring becomes wider when the ring is heated. Does it follow that if small amounts of oxygen are good for you then large amounts of
oxygen would be especially good for you? Competent scientists must be experts at changing their minds. Normal faults result from tensional stress. Although the two types differ in design and composition, they function by the same principle: two materials that oxidize and reduce each other are connected by a medium through which ions travel to
balance an external flow of electrons. Monomers of 6-aminohexanoic acid combine by splitting off water molecules to form the polymer known as nylon-6: H N N H FIGURE 19.34 Flexible and flat video displays can now be fabricated from polymers. When added to water, ammonia behaves as a base as its nonbonding electrons (Section 15.1) accept a
hydrogen ion from water, which, in this case, behaves as an acid: Positive hydrogen ion (lone proton) \ge \le h H2O \le NH3 H \le C H A P T E R 18 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S 457 FIGURE 18.4 Hydroxide ions have a net negative charge, which is a consequence of having lost a
proton. But what would happen if the cannonball were instead fired at the same speed vertically? Should something be done about it? A small block of ice at 0°C is subjected to 10 g of 100°C steam and melts completely. The energy of the absorbed light increases the kinetic energy of the atoms, and the glass is warmed. Bar magnets are moved into
the wire coils in identical quick fashion. For instance, to represent the chemical reaction in which carbon combines with oxygen to produce carbon dioxide, we write the chemical equation using coefficients of 1: 1 C(s) 

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Practice articulating and paraphrasing the concepts represented by the boldface terms. Once synthesized, the compound produced in the laboratory is chemically identical to that found in nature. Sodium chloride and potassium chlor
show how they can be separated by physical means. Because the Mercalli scale is subject to an observer's interpretation, it is a useful yardstick but not very precise. Similarly, we humans on the surface of Earth CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E 777 drive our cars around as though the world is flat. How many moles of
molecules are there in: (a) 28 g of nitrogen, N2; (b) 32 g of oxygen, O2; (c) 32 g of methane, CH4; (d) 38 g of fluorine, F2? With each step, the composition of the remaining liquid magma changes. What is it that the appliance actually consumes, and what becomes of it? Consider a bowling lane that completely surrounds Earth, elevated high enough to
be above the atmosphere and air resistance. (c) absolute instability. The absolute temperature scale is called the Kelvin scale, named after the famous British mathematician and physicist William Thomson, First Baron Kelvin. A How is solar energy trapped inside an automobile on a sunny day? How much of the original sample will be left at the end of
the second week? A projectile is launched upward at an angle of 75° from the horizontal and strikes the ground a certain distance downrange. Deposition does not cause the foliated texture in metamorphic rocks. If you visit Mars, never mind your raincoat, for there is far too little water vapor in the atmosphere for rain. Given a choice between a
closed mind with comforting answers and an open and exploring mind without answers, most scientists choose the latter. Use conservation of energy to find its kinetic energy at that point. F F C H F C F C H F Was this your answer? Treat with NaOH Fat molecule Three fatty acid soap molecules Glycerol molecule In the 1940s, chemists began
developing a class of synthetic soaplike compounds, known as detergents, that offer several advantages over true soaps, such as stronger grease penetration and lower price. It is infinitely soluble in water, and it is the active ingredient of alcoholic beverages. In a cold winter the ice is thicker than in a mild winter. In general, adding anything to water
lowers its freezing temperature. Some unknown form of matter might lurk just outside our solar system, perhaps within the Oort cloud. When only weak attractions exist between the molecules from one another and allow them to enter the gaseous phase. A coil of non-insulated wires
touching one another would be a short circuit. (d) are mainly empty space. What does WMAP stand for? Antinoise devices are also common in some aircraft, which are much quieter inside than before this technology was introduced. While the soccer ball falls, its speed (a) and acceleration both increase. For example, steel has a high elasticity, while
fresh bread has a low elasticity. In this case the desk picks up speed. Because the dry leeward sides of mountain ranges are sheltered from rain and moisture, rain-shadow deserts often form. 6 CO2 + 6 H2O h C6H12O6 + 6 O2 75. If all 40 million J of energy in 1 L were used to do the work of overcoming the air resistance and frictional forces, the
distance would be Distance = LEARNING OBJECTIVE Identify and describe the two ultimate sources of energy on Earth. FIGURE 21.24 Simplified view of convection cells within the mantle, showing slabpull. (Recall that 1 mt is 1000 kg.) 44. The atomic number of uranium is 92, which tells us that 92 of these 238 nucleons are protons. There is more
thermal energy in the full glass (twice the matter at the same temperature). TA B L E 5 . F I G U R E 3 .1 6 Work is done in lifting the barbell. Shock wave The cone-shaped wave made by an object moving at supersonic speed through a fluid. (a) Chemical, (b) chemical, (c) physical, (d) physical. Consider an area at the bottom of a vessel that contains
liquid. Thus, as shown in Figures 15.4 and 15.5, the positive ion formed from the fluorine atom is written F1-. An ideal machine would operate at 100% efficiency. EDTA has a strong affinity for lead ions, Pb2+, because the + 2 charge of the lead ion is attracted to the two -1 charges
of the EDTA molecule. (b) Charge flows in a circuit. Show that a net force of 84 N is needed to give a 12-kg package an acceleration of 7.0 m/s2. Drumlins are depositional features in which the steep side points in the direction of glacial retreat. Haiti was unprepared—no building codes, no earthquake education, no earthquake disaster plans, and no
money. 86 PARTONEPHYSICSEXERCISES (SYNTHESIS) 74. Hence, reactions are generally slower at lower temperatures. The work the hammer does on the nail is F*d, and the temperature change of the nail can be found from Q = cm©T. Furthermore, medieval alchemists noted that certain minerals (which we now know are made up
of group 2 elements) do not melt or change when put in fire. At some point in time the pulses meet and interact (interfere) with each other. The stronger the bond, the harder the mineral. When clouds develop in stable air, they too spread out into thin horizontal layers having flat tops and bottoms. Although light Wavelength can pass through many
materials, it needs none. What kind of force field surrounds a stationary electric charge? A chain reaction is more likely to occur in two pieces of uranium-235 stuck together. MasteringPhysics ® This online homework and tutoring system delivers self-paced tutorials that provide individualized coaching, focus on your course objectives, and are
responsive to each student's progress. This force is large enough to lift a heavy weight. Plasmas exist in stars, where the temperature is millions of degrees Celsius. They also believed that the cooling of the planet resulted in its contraction, which caused the outer skin to contort and wrinkle into mountains and valleys. What three sources of heat
contributed to the melting and density segregation of early Earth? The Pacific Plate is moving northwest at a rate of about 5.0 cm/yr relative to the North American Plate. Given that this reaction involves only one reactant and one product, you should not be surprised to learn that 64 g of reactant produces 64 g of product. He recognized a sharp
increase in the speed of seismic waves at another boundary, one that lay at a shallower depth below Earth's surface. Reflection, sound The return of a sound wave; an echo. The greater area reduces the support pressure. How much of the CH4 will react? The temperatures in a fractionating tower at an oil refinery are important, but so are the
pressures. Parabola The curved path followed by a projectile under the influence of constant gravity only. FYI 716 PA R T F O U R ASTRONOMY Not all of the Venusian FYI water was lost to space. The denser the air, the more molecules are present and hence the greater the number of molecular collisions. These impulses are internal to the system
comprising the cannon and the cannon
together by increasing the effect of the strong nuclear force, represented by the single-headed arrows. F I G U R E 6 .1 7 A bimetallic strip. Do you suppose these layers in Earth's interior influence the geologic changes our planet experiences? We know a lot about where we are, but nothing really about why we are. Although Ceres is large enough to
be fairly round, most asteroids are shaped more like a potato, as shown in Figure 26.38. And thus you listen to the sound of music. We have adapted so completely to the invisible air that we sometimes forget it has weight. Potter's clay is soft at room temperature. Silica cement, the most durable, produces some of the hardest and most resistant
sedimentary rocks. Circuits that carry more than a safe amount of current are said to be overloaded. Write the full balanced chemical equation that is depicted. (Almost all the molecules are present to begin with. As described in the Big
Bang Helium box, the Big Bang model predicts that the early universe would have been favorable to change the linear momentum of an object, an external net torque is required to change the angular momentum of an object. When an electric
current passes through the coil, each loop produces its own effect on the needle, so even a very small current can be detected. The ratio of circumference to diameter is the same for both large and small circles (Figure 2.10). After two monomers have joined, reactive ends
still remain for further reactions, which leads to a growing polymer chain. The universal law of gravity (see Chapter 4) is an inverse-square law: the strength of the natural world is now much deeper. Wegener prepared a detailed hypothesis to explain
this observation. 25 21 Dec. The distance between the 1-kg mass and the center of Earth is Earth's radius, 6.4 * 106 m. Soap or detergent molecules, therefore, give up their sodium ions to bind selectively with calcium or magnesium ions: Ca2 FIGURE 16.24 Hard water causes calcium and magnesium compounds to build up on the inner surfaces of
water pipes, especially those used to carry hot water. So entropy increases with disorder in a system. Predict what occurs. Yes! This is adiabatic expansion or compression. This led to the accretion of the nebular disk into small objects called planetesimals, which ranged in size from boulders to objects several kilometers in diameter. How large, then
might be the entire universe—the whole shebang? (a) 100,000 years ago (b) Today (c) 100,000 years in the future F I G U R E 2 7. Sailors have not always known, however, that a sailboat can sail against the wind. Stare intently for at least a half minute at an American flag. This means that fish remain in relative warmth! -10°C Ice 0°C 4°C FIGURE
6.23 As water cools, it sinks until the entire pond is at 4°C. As you continue to add sugar, however, there comes a point when it no longer dissolves. If there are so many stars and galaxies, why do we see so much darkness in the clear night sky? 26. Fry (University of Wisconsin), H. The luster of a mineral is the way its surface appears when it reflects
light. CHAPTER 7 H E AT T R A N S F E R A N D CH A N G E O F P H A S E The pressure of the variounding liquid. The second thing to notice is that the vertical positions become farther apart with time. The osmotic pressure for seawater, however, is an
astounding 24.8 atm (365 psi). FYI LEARNING OBJECTIVE Define a mineral. FYI F I G U R E 1 5.1 7 Two hydrogen atoms form a covalent bond as they share their unpaired electrons. Which portion of a soap molecule is nonpolar? (b) lower frequency. 3 The Her tzsprung - Russell Diagram 27. Earth's interior is separated into layers, much as oil and
vinegar in salad dressing separate into their respective layers. TUTORIAL: The Nature of Acids and Bases F I G U R E 1 8 .1 (b) (a) (d) (c) Examples of acids. If this spiraling storm isn't broken apart by upper-level winds, it can develop into a tropical depression (wind speed less than 60 km/h), so called because of a central area of low pressure. The
lithospheric plates are always in motion. The nitrogen monoxide formed in this manner undergoes further reactions to form nitrate ions that plants depend on for survival, as was discussed in the opening of this chapter. The great variety of substances results from the many ways a few kinds of atoms can be combined. But how does this tablet react to
a solution of half water and half corn syrup? Defend your answer. Se. Evidence for the existence of neutrons did not come until many years after the discoveries of the electron and the proton. cience and human conditions advanced dramatically after science and mathematics became integrated some four centuries ago. Makes sense! Faults When
stress is stronger than rock and conditions are not hot enough or pressure not high enough for plastic deformation, brittle deformation occurs, and rock can fracture into separate blocks. otice in the graph of Figure 13.30 that the steepest part of the energy valley goes from hydrogen to iron. Try this for yourself! If the bubbling is not as vigorous as
shown here, then the chalk is made of other mineral components. 21.4 Acceptance of Continental Drift EXPLAIN THIS O How do magnetic pole reversals support seafloor spreading? Compared to the size of the entire Milky Way galaxy, these thousands of stars form our immediate neighborhood. They are very common in winter, and they account for
the sky's "hazy shade of winter." They resemble a high fog that doesn't touch the ground. Hurricane Katrina formed on August 23, 2005, near the Bahamas. We know that a compass points northward because Earth is a giant magnet. (c) Discuss why your answers are the same or different. At a baseball game a ball of mass m = 0.15 kg moving at a
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speed v = 30 m/s is caught by a fan. No; Bohr's model merely illustrated the different energy levels of an electron in an atom. M F I G U R E 7. ** Interestingly enough, this might well be called the maximum falling speed. Such an arrow is called a vector. This form of matter, however, interacts only with the gravitational force. If you phone two friends
who have made similar measurements of the same event from different locations, you can transfer their circles to your map, and the point where the three circles intersect is the location of the disturbance. What would be the path of the Moon if somehow all gravitational forces on it vanished to zero? As P-waves move through the outer core, there is a
depth at which their speed suddenly increases. According to the laws of gravity, orbital speed is a function of the force of gravity between the orbital speed two balls from the top of the Leaning Tower of Pisa, air resistance was
not really negligible. The halogen returns as a gas while the tungsten is deposited onto the filament, thereby restoring the filament. Rank these minerals in order of partial melting: (a) quartz, (b) feldspar, (c) olivine, (d) pyroxene. The tilt of the Earth is responsible for the seasons. Because of the curvature of Earth, these parallel lines eventually merge
at the poles. How is it possible for there to be this decrease in entropy for a process that occurs all by itself? Both sides of the equation are then equal. This illustrates the scattering of blue to the side and the transmission of light of lower frequencies, the
bluer colors rather than the redder colors are accented. Remember, the entire lithosphere—the uppermost mantle and crust— "floats" on the asthenosphere. What might happen to the free-base form of caffeine (an alkaloid) dissolved in diethyl ether if gaseous hydrogen chloride, HCl, were bubbled into the solution? Some examples of scalar quantities
are speed, time, temperature, and energy. When food is irradiated with gamma rays from a cobalt-60 source, does the food become radioactive? Iron atoms have a greater tendency to oxidize than do copper atoms. Tests of General Relativity F I G U R E 2 8 .1 4 A precessing elliptical orbit when viewed from directly above is seen to advance forward
in its orbit. Give your answers in whole numbers. The Core Earth's core is composed mainly of iron and smaller amounts of nickel. In a similar fashion, the properties of an element depend on the arrangements of electrons in its atoms, especially the outer-shell electrons. Once the value of G was known, the mass of Earth was easily calculated. This
molecule is therefore nonpolar: F F C & C F A water molecule is a natural dipole—a bit positive on one end and negative on the other. Collectively they are known as the transition metals, a name that denotes their central position in the periodic table. In this way, they become gas. The Wilkinson Microwave Anisotropy Probe, which provided a high
resolution of cosmic background radiation. Let these two elements react with each other, however, and you can safely sprinkle the compound on your popcorn for better taste. M FIGURE 10.40 Node Physics of music. (c) Does the mass of there are the mass of the 
ball make a difference? The study of carbon-containing compounds has come to be known as organic chemistry. If the attractions are strong, however, the particles may be held together in the solid phase. A small portable instrument that measures atmospheric pressure is the aneroid barometer (Figure 5.28). Physicians use the multiple reflections
and refractions of ultrasonic waves to "see" the interior of the body without the use of X-rays. Thermal contact is not required with infrared thermometers that show digital temperature readings by measuring the infrared thermometers that show digital temperature readings by measuring the infrared thermometers that show digital temperature readings by measuring the infrared thermometers that show digital temperature readings by measuring the infrared thermometers that show digital temperature readings by measuring the infrared thermometers that show digital temperature readings by measuring the infrared thermometers that show digital temperature readings by measuring the infrared radiation emitted by all bodies.
small objects in the solar system, it is not spherical. Sodium chloride does not react chemically with water the way sodium does; not only is it not toxic to humans, which chlorine is, but the very opposite is true—it is an essential component of all living organisms. Why is the tennis ball easy to catch despite the fact that the jet is moving so fast? To
make the net force zero, a force of 40 N backward must be exerted on the car. Most of the individual storms are not severe, but thunderstorms sometimes become organized and begin to behave as a single system called a tropical disturbance. CHECKPOINT Oxygen is a good oxidizing agent, but so is chlorine. Molecules at the surface that gain kinetic
energy by being bumped from below are the ones to break free from the liquid. What net effect does a chemical reactions, matter/energy conversions are much more pronounced. In other words, it is in equilibrium. The slow spin of Venus means that the
atmosphere is not disturbed by the Coriolis effect described in Chapter 24. (b) Melting point increases as silica percentage increases. If cooling occurred at the bottom up? Today, Big Bang theory tells us that the universe is changing. The physical sciences branch into such areasen.
as physics, chemistry, the Earth sciences, and astronomy. For example, a bowl of warm water contains more thermal energy than does a red-hot thumbtack. As its name implies, this functional group can donate hydrogen ions. Should you be concerned? Shorter waves are canceled as the speakers are brought closer together, and when the two
speakers are brought face to face against each other, very little sound is heard! Only the highest frequencies survive cancellation. Soon they grow impatient waiting for you and they leave you behind for dead. If each crate will push the barge 4 cm deeper, the question becomes: How many 4-cm increments will make 15 cm? Crystals are largest at the
contact, and get smaller with distance from that point. b. Dark or black skin absorbs ultraviolet radiation before it can penetrate too far. If it takes 436 kJ to break a bond, how many kilojoules are released when the same bond is formed? But neutrons are not always successful in keeping a nucleus intact. Hold the bottom end of a test tube full of cold
water in your hand. The hydrogen side of a polar molecule (water, in this example) has a positive charge because the more electrons of the covalent bond. It is not necessary to wait through the duration of a half-life in order to measure it. If a baseball could be thrown fast enough to travel a
horizontal distance of 8 km during the 1 s it takes to fall 5 m, then it would follow the curvature of Earth. Why isn't it still directly above you? CHAPTER 14 1. Chemical properties characterize the tendency of a substance to react with or transform into other substances. They cannot begin to crystallize until lower temperatures are reached. There are
two reasons for this: F F I G U R E B .1 3 W I N D 1. Solution: SAM PLE PROBLEM 2 Yes. Saturation vapor pressure The maximum amount of moisture the air can accommodate at a given temperature; the upper limit for humidity. What is the net force on the apple when you release it? The three hydrogen isotopes have special names: protium for
hydrogen-1, deuterium for hydrogen-2, and tritium for hydrogen-3. The molecule looks different in each conformation, but the five-carbon framework is the same in all three conformations. Impulse is what an object can provide or what it can experience when it interacts * The symbol for momentum is p. The planets of our solar system orbit in roughly not can be a conformation of the same in all three conformations.
the same plane, which is the plane of our solar system. (You can express g in units of N/kg because m/s2 is equivalent to N/kg.) 44. How do humans generate the air pollutant sulfur dioxide? As air makes contact with these cold surfaces, it cools and its ability to hold water vapor decreases. Fault plane FIGURE 21.33 A reverse fault. It would be
nighttime because you would be directly between Earth and the Sun. a 3. Only if their eyes are at the very same location will they see exactly the same rainbow. More important than the force with which you pump is the timing. Or when we say a racing car reaches a speed of 300 km/h, we mean relative to the track. The best way to answer any
question about b b the conformation of a molecule is to play a a c c d around with molecular models that you d can hold in your hand. Remember that any object above absolute zero emits energy in the form of electromagnetic radiation. Chemistry is the study of (a) matter. Rock can be up-folded or down-folded. They may estimate 2 or 3 s. This is
similar to billiard balls that gain speed at the expense of others that lose speed. 1.7 Dynamic Equilibrium 17. You will see that after 90° the Sun is setting over New York City, which is east of Los Angeles. Show that the electric force between them is 10 N. nuclear force diminishes rapidly over distance, nucleons must be practically touching in order
for the strong nuclear force to be effective. One newton is the force needed to give a mass of 1 kg an acceleration of 1 m/s2. Since the dates of pole reversal can be determined, the magnetic pattern of the spreading seafloor documents both the age of the seafloor documents both the age of the seafloor and the rate at which it spreads. Pyrite Hematite Copper Silver Gold Why are most rocks
made of silicate minerals? Most comets usually last only a couple of orbits before they break up. If a uranium nucleus stretches into an elongated shape (Figure 13.21), the electric forces may push it into an even more elongated shape (Figure 13.21) and explode like a Big Bang into another universe. Which type(s) of rock is (are) made from
previously existing rock? CHAPTER 3 MOMENTUM AN D ENERGY 75 FIGURE 3.24 Because of friction, energy is transferred both into the floor and into the floor and into the floor and into the tire when the bicycle skids to a stop. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 20.1 The Geosphere Is Made Up of Rocks and Minerals 1. In solution with water, it slowly
decomposes to produce oxygen gas. A Brief History of Advances in Science? The space defined by the shell exists whether or not an electron is to be found there. 12-V ac is connected to the primary. The limbs of an anticline (an up-fold) tilt away from the axis of the
fold (a marble would roll away from the axis), and the rock layers are oldest at the core of the fold. A beta particle is normally faster than an alpha particle and carries only a single negative terminal, and they always move through the circuit in the same
direction. So how might a gallium, Ga (atomic number 31), chip compare with a germanium chip? If we never see the back side of the Moon, would an observer on the back side of the Moon ever see Earth? FIGURE 15.37 Temporary dipoles induced in the normally nonpolar molecules in plastic wrap make it stick to glass. CHECKPOINT If you wish to
take a picture of your image while standing 5 m in front of a plane mirror, for what distance should you set your camera to provide the sharpest focus? How does he accomplish his apparent levitation in midair? Through special relativity, Einstein showed how matter and energy are really two forms of the same thing as related by his now famous
equation E = mc 2, introduced in Chapter 13. It makes sense that hydrogen was the original element. Sodium metal and chlorine gas react together to form sodium chloride. As we discussed in Chapter 3, energy from a source, whether fossil or nuclear fuel or wind or water, is converted to mechanical energy to drive the turbine. Slate is also
commonly used as roofing tile and floor tile. The acceleration due to gravity is symbolized by g. This analogy is used to explain how inflation diminished the apparent curvature of the observable universe. So if you want to point to the location of the Big Bang, just point your finger to the tip of your nose, or anywhere for that matter. Joined spheres
represent molecules. Furthermore, if this illustration were drawn to scale, the atomic nucleus with its protons and neutrons would be too small to be seen. (b) Equal like charges. When cirrostratus clouds thicken, they give the sky a white, glary appearance—an indication of an advancing storm. This combining of nuclei is nuclear fusion—the opposite
of nuclear fission. Any change in a substance that involves a rearrangement of the way atoms are bonded is called a chemical change. H O W CH EM I C A L S R E AC T 441 Tail pipe to atmosphere H2O O2 CO2 N2 After it has passed through the catalytic converter, the exhaust contains water vapor, N2, O2, and CO2. For example, the 2010 explosion
of BP's Gulf of Mexico oil rig is, to date, the largest accidental oil spill in history. 1620 3240 4860 329 Years F I G U R E 1 3 .1 5 INTERACTIVE FIGURE Every 1620 years the amount of radium decreases by half. By volume, this solution is 78% nitrogen gas, 21% oxygen gas, and 1% other gaseous materials, including water vapor and carbon dioxide.
This is another case where the existance of molecules helps to explain the observed phenomenon. A photon of light is absorbed. One unknown, as of the writing of this textbook, is the nature of dark matter. Hydrogen is the lightest gas, but it is seldom used because it is highly flammable. This "alteration in space" is called FIGURE 8.8 The negatively
charged balloon polarizes molecules in the wooden wall and creates a positively charged surface, so the balloon sticks to the wall. Although the half-life might be 10 years, any individual atom might last for only a few days, while others last for well beyond 10 years. When they jiggle at a very slow rate, they form solids. As he dives, his potential energy
converts to kinetic energy. A carbon-oxygen bond is more polar. Many organisms, including people with defective color vision, do not see the rose as red at all. The buoyant force is equal to the weight of 9.8 N. A sodium ion and a chloride ion together
make the chemical compound sodium chloride, commonly known as table salt. Recall from Chapter 24 that air pressure decreases with increasing height. FYI of kinetic energy of the alpha particle (42He), partly in the kinetic energy of the thorium atom, and partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha particle (42He), partly in the kinetic energy of the alpha partly in the kinetic energy of t
easily observSodium ion able physical properties. Each year about 1.6 * 107 (16 million) metric tons (mt) of aluminum are produced. According to the principles of original horizontality and superposition, the layers could not have been deposited in this order. When magma reaches the ocean floor, undersea volcanoes form, which often start out with
basaltic lava. T How is the periodic table like a dictionary? (c) The caprylaldehyde behaves as a reducing agent, which neutralizes the sodium hydroxide. The Falkirk Wheel in Scotland (see Figure 5.17) rotates with the same low energy no matter what the weight of the boats it lifts. (Hint: Does the balloon's density change?) 111. Its igneous crust is
thicker than Earth's. Tap water is a mixture of dihydrogen oxide plus impurities. Number of Ping-Pong balls 10 g = Number of golf balls 200 g CHECKPOINT A customer wants to buy a 1:1 mixture of blue and red jelly beans. What are the inward forces that act on a star? its gravitational field. Whatever the system—be it a steam engine, Earth's
atmosphere, or the body of a living creature—heat added to it can have two effects. (c) black hole. What is metamorphism? What combinations of tones we have learned to focus our attention on determines what we hear when we listen to a concert. Note that after the speed of the source exceeds wave speed, increased speed produces a narrower V
shape.* Whereas a speedboat knifing through the water generates a two-dimensional bow wave at the surface of the water, a supersonic aircraft similarly generates a three-dimensional shock wave. A dollar bill (which represents wealth but is really only a piece of paper), air pollution, and the spread of sexually transmitted disease would be described
using a conceptual model. Instead, the energy of vibrating electrons is re-emitted as light. Then reaction is the falling object pulling Earth upward. In such a device, vapor pressure builds up inside and prevents boiling. Note that the apparent brightness of a star is not its luminosity. To be more precise, the average atmospheric pressure at sea level is
101.3 kPa.* The pressure of the atmosphere is not uniform. Why does energy have mass? So the net force on the craft is forward, to the right. When the isotope bismuth-213 emits an alpha particle, what new element results? FYI 100 200 km (c) F I G U R E 2 0 .1 9 The three types of volcanoes. CHECKPOINT F 1. (d) increased atmospheric pressure.
C, B, A. Bigger stars live shorter lives and collapse more energetically when they burn out. All living things, from bacteria to trees to human beings, extract energy from their surroundings and use this energy to increase their own organization. (c) If the ball reached the same height as when tossed at some other angle, would the time of flight be the
same? Why is it impossible to breathe through a snorkel when you're under more than a meter of water? Each molecule has its own unique set of physical, chemical, chemical was moist? Asthenosphere (plastic) Upper mantle 800
1000 Lower mantle 2885 5155 6371 Outer core Inner core FIGURE 21.6 The core, mantle, and crust each have a different composition. This is in accord with 🛭 = 0. In water it sinks because it cannot displace its weight. Earth's lithospheric plates move in a conveyor-belt manner in response to mantle convection. Fast Twice as fast? Concentrations
of neutrinos released from the collapse of the iron core are great enough to blow the outer shells of the star outward at speeds in excess of 10,000 km/s, which is fast enough to travel 1 AU in about four hours. The products of this reaction are a chloride ion and a hydronium ion, H3O+, which, as Figure 18.3 shows, is a water molecule with an extra
proton. 10 Acceleration Greek scientists understood some of the physics we understand today. As evaporation proceeds, the minerals with the lowest solubility—the most difficult to dissolve—such as gypsum precipitate first, followed by the minerals with the lowest solubility—the most difficult to dissolve—such as analydrite and then halite. One is the
downward pull of gravity, your weight, and the other is the upward support force of the floor. Citral and camphor are both 10-carbon odoriferous natural products made from the joining of two isoprene units plus the addition of a carbonyl functional group. 5 2 (a) A vertically plane-polarized wave from a charge vibrating vertically. (a) Show that the
altitude of the airplane is 4.4 km. This distance, as introduced in Chapter 1, is given by d = 12 gt 2, where t is the elapsed time. 710 PA R T F O U R ASTRONOMY TA B L E 2 6. Many such statements are quite reasonable and useful, but they lie outside the domain of science. According to the theory, the solar system began to condense from the cloud
of gas and dust about 5 billion years ago. In his lifetime he was regarded by his countrymen as the greatest scientist who ever lived. (Before you say yes, note the behavior of the stream when an opposite charge is brought nearby.) 210 PA R T O N E P H Y S I CS 34. A fully eclipsed Moon is not completely dark in the shadow of Earth but is quite
visible. Consider the example of Supernova 1987a (a supernova is the explosion of a star, as you will learn more about in Section 27.4). For our purposes, an appropriate definition is the one suggested in 1923 by the Danish chemist Johannes Brønsted (1879-1947) and the English chemist Thomas Lowry (1874-1936). The average temperature of the
universe right now is about 2.73 K. The force that propels the balloon is provided by the (a) surrounding air. (c) Many toilet bowl cleaners are formulated with hydrochloric acid, H2CO3; many also contain phosphoric acid, H3PO4. As neutrons in a nucleus change into protons, the stability of the
nucleus decreases because the repulsive electric force becomes increasingly significant. The foil also retains moisture. = , where x = 100 turns * = 1200 V. But the single largest source of mercury emissions in the exaggerated view of
Figure 11.47. Mastering Physics (and a to be the length of the electric field about an isolated point charge has a certain value at a distance of 1 m. We define L to be the length of the object, and a to be the fractional change per unit length for a temperature change of
1°C. Solution: (1.39 * 106 km) (1 AU > 1.5 * 108 km) 4 0.01 AU 1 AU = 100 0.01 AU 1 AU = 100 0.01 AU The diameter of the Sun is about 100 times the diameter of the Sun is about 100 times the diameter of the Sun is approximately equal to 0.01 AU, so the distance between Earth and the Sun is approximately equal to 0.01 AU and 1 AU = 100 0.01 AU.
the hot core and mantle to the cooler crust. For water, this is a whopping 2256 J/g. And as we will soon see, this is why the most common group of rock-forming minerals—the silicate group—is dominated by these two elements. Try bouncing a coin off another on a smooth surface, as shown. Elements in the same period have electrons in the same
shells. b, d, c, a. The structure of hydrogen peroxide is H i O i O i H, where each H i O i O bond is bent to an angle (similar to water's structure). (c) The atomic masses are average atomic masses. This is easier to see here because both balls convert the same PE to KE. Cyclopropane Propene 39. L I N E A R A N D R O TAT I O N A L M O T I O N well
as magnitude. In 1968 the term degrees Kelvin (°K) was officially changed to simply kelvins (lowercase k), which is abbreviated K (capital K). When will our Sun reach the red-giant stage? But the equation tells us little about what occurs on the submicroscopic level during the reaction. FYI Hydrogen bomb 100,000,000 K Center of the Sun 20,000,000
K Surface of a hot star Plasma 50,000 K 20,000 K Surface of the Sun 6000 K All molecules have broken up; 4300 no solids or liquids Carbon arc lamp 4000 K +200°C +100°C * Even at absolute zero, molecules still possess a small amount of kinetic energy, called the zeropoint energy. For example, we say that there are more than 100 to 100 K and 100 K are liquids Carbon arc lamp 4000 K +200°C +100°C * Even at absolute zero, molecules still possess a small amount of kinetic energy.
kinds of atoms, and that any material consisting of a single kind of atom is an element. Gravitational forces would then ensure that these bits of clumpiness would be the seeds for further clumpiness, which would eventually give rise to such things as galaxies and superclusters of galaxies. As a pulsar spins, the beam of radiation it emits sweeps across
the sky. Many scientists focus on basic research, which leads us to a greater understanding of how the natural world operates. 108. Does light travel faster in thin air or in dense air? Electrons in the outermost occupied shell of any atom may play a significant role in that atom's chemical properties, including its ability to form chemical bonds. Here
ference in representation is because of the difference in bond types. elements, 356 Atomic mass, 299-300 Atomic nucleus mass of, 338-339 strong nuclear force and, 326-328 Atomic number, 298 Atomic spectrum, 309-311 Atomic symbol, 296-297 Attractive forces atomic. ** Rather than the term thermal energy, physicists prefer the term internal
energy, to emphasize that the energy is internal to a body. FYI Converting between Grams and Moles Atoms and molecules react in specific ratios. The reason? When a ball is tossed straight up, it momentarily comes to a stop at the energy released
by the earthquake. An ostrich egg of mass m is tossed at a speed v into a sagging bed sheet and is brought to rest in a time t. But with a larger intrusive body, such as a batholith, the altered zone may be 100 m thick or more. Higher temperatures, therefore, increase reaction rates. For example, if my rope underwent a decrease of 50 N, would Burl's
rope gain 50 N? It is also evident as water flowing from a garden hose speeds up when you squeeze the end of the hose to make the stream narrower. It is interesting to note that the Sierra Nevada is gaining height with time—long after all the magma has crystallized—because its rate of uplift is greater than its rate of erosion. On one side of the
ellipse, called the perihelion, the planet is closer to the Sun than on the other, called the aphelion. We can represent all these planes by radial lines, shown in Figure 11.53b. A protective, water-insoluble oxidized coat is the principle underlying a process called galvanization. Which is more likely to hurt: being stepped on by a 200-lb man wearing
loafers or being stepped on by a 100-lb woman wearing high heels? Look to the agents of weathering to guide your thinking. FYI f &T Stars have different colors because they emit different frequencies of electromagnetic waves in the visible range. White is produced where all three overlap. Conversely, temperature goes up when pressure goes up-
air pressure dry air that expands adiabatically changes by about 10°C for each goes up when air is compressed. In 1960, he proposed that the seafloor is not permanent but is constantly being renewed. 16.2 The Chemist's Classification of Matter Is frozen apple juice an example of a solution, suspension, or heterogeneous mixture? Yes, it is important
Without the different rates of expansion, a bimetallic strip would not bend when heated (or when cooled). Every contact requires at least a twoness; there is no way that an object can exert a force on nothing. If the secondary has fewer turns than the primary, the ac voltage induced in the secondary is lower than that in the primary. The reactants
shown schematically on the left represent iron oxide, Fe2O3, and carbon monoxide, CO. CHAPTER 1 1.1 PAT TERNSOFMOTION ANDEOUILIBRIUM Aristotle's influence on classifying motion. What term is used to describe the minimum amount of energy required in
order for a reaction to proceed? Astronauts in orbit are in a state of continual free fall. F I G U R E 1 8 .1 0 The relative concentrations of hydronium and hydroxide ions determine whether a solution is acidic, basic, or neutral. The monomer propylene, for example, yields polypropylene, as shown in Figure 19.28. You come into a crowded and chilly
classroom early in the morning on a cold winter day. The result is that the large nucleus is less stable. Bernoulli's principle plays a small role when your bathroom shower curtain swings toward you in the shower when the water is on full blast. Among stars originating from the main sequence, which are larger: red stars or yellow stars? (c) There's no
defense. Energy from the Sun energizes atoms and molecules and keeps them in motion. Different bonds involving different bond energizes, as Table 17.1 shows. Schist forms under higher temperature and pressure conditions than slate, which causes the mineral grains to grow large enough to be identified with the naked eye.
moves the mode of decomposition from anaerobic to less smelly aerobic microorganisms. 1.1 Aristotle on Motion 1. Similarly, atoms of the last group, including helium, neon, and argon, each have their outermost shell filled to capacity with electrons—two for helium and eight for both neon and argon, each have their outermost shell filled to capacity with electrons—two for helium and eight for both neon and argon. For example, one geographic area may have rocks
with one set of minerals, while the adjacent area has rocks with a different set of minerals. The bug is not traveling anywhere but merely treads water in a stationary position. Does this mean the diver comes to a stop? Calculate the horizontal force that must be applied to a 1-kg puck to accelerate on a horizontal friction-free air table with the same
acceleration it would have if it were dropped and fell freely. Furthermore, when the Sun (or Moon) is near the horizon, the rays from the lower edge are bent more than the rays from the upper edge. Internal pressure within flowing water and the external pressure it can exert on whatever it encounters are two different pressures. And with clouds can
come precipitation. Where streamlines of a fluid are closer together, flow speed is greater and pressure within the fluid is lower. Or, in shorthand notation v = at. This 3 g will react with the 8 g of oxygen to form 11 g of carbon dioxide. The key to this relationship is the mole. So most substances, such as iron, aluminum, and most metals, are denser in
the orbit of Uranus. Which contains more hydrocarbon molecule? The radio loudspeaker is a paper cone that vibrates in rhythm with an electrical signal. Coal deposits are found in some eastern states, such as Pennsylvania and West Virginia. As Figure 19.19
relates, tannins are also responsible for the stains caused by these beverages. What happens is that the cannonball continuously falls beneath the imaginary line until it finally strikes the ground. If the mass of a sliding block is tripled at the same time that the net force on it is tripled, how does the resulting acceleration compare to the original
acceleration? In the Devonian period (known as the "age of fishes"), fish diversified into many new groups (the sharks and bony fishes are still present today). The scale is logarithmic. Correspondingly, an electric field is induced in any region of space in which a magnetic Generator An electromagnetic induction device that produces field is changing
with time. Of course, to wrinkle sections of rock requires strong forces, which come from the movement of lithospheric plates. Isn't this astounding? Secondary waves, like the waves produced on a vibrating vioLove wave (c) lin string, are transverse—they vibrate the particles of their medium up and down and from side to side, perpendicular to the
direction of wave travel. 4 Any element consists of only one kind of atom. Solution: Divide our distance from Proxima Centauri by our distance to the Sun: 4.2 [email protected] = 262,500 0.000016 [email protected] So the nearest star is about 260,000 times as far from us as the Sun is. Is space just the absence of matter? At any given temperature,
there is a wide distribuKinetic energies in reactant molecules. Understanding buoyancy requires understanding the meaning of the expression "volume of water displaced." If a stone is placed in a container that is already up to its brim with water, some water overflows (Figure 5.9). If you punch a hole in the side of a container
filled with water, in what direction does the water initially flow outward from the container? We say they undergo acceleration. Before a theory is accepted, it must be tested by experiment and make one or more new predictions—different from those made by previous theories. Given that the total number of atoms on our planet remains fairly
constant, how is it ever possible to deplete a natural resource such as a metal? In its early history, it was intensely bombarded by meteoroids (as was Earth). Such a sequence, illustrated in Figure 13.22, is called a chain reaction event stimulate further reaction events. Rank the
materials according to how much the light ray bends toward the normal, from most bending to least bending to least bending to how much the loop alternates so that the forces in the upper and lower regions do not
change directions as the loop rotates. The straightchain hydrocarbons, such as heptane, burn too quickly, causing what is called engine knock, as illustrated in Figure 19.4. Gasoline hydrocarbons that have more branching, such as isooctane, burn slowly and result in the engine running more smoothly. This question should elicit much discussion! 105
Such is the case with dark energy. For general physics input to previous editions, we remain grateful to Dean Baird, Tsing Bardin, Howie Brand, George Curtis, Paul Doherty, Marshall Ellenstein, Ken Ford, John Hubisz, Dan Johnson, Tenny Lim, Iain McInnes, Fred Myers, Diane Reindeau, Kenn Sherey, Chuck Stone, Larry Weinstein, David Williamson,
and Dean Zollman. The closer a planet is to the Sun, the faster it orbits. But, by the inversesquare law, the nearer hand should appear to be twice as tall and twice as much of your visual field as the farther hand. Hurricane Katrina, however, was such a large storm that it devastated areas of the Gulf
Coast up to 160 km from the eye of the storm. Many people can leap over a 1-m fence, but only rarely does anybody raise the "center of gravity" of his or her body by 1 m. Generally, element is used in reference to an entire macroscopic sample, and atom is used when speaking of the submicroscopic particles in the sample. Why doesn't
a magnet pick up a penny or a piece of wood? Which type of cloud can become a thunderhead? (d) zero. Pressure there is more reduced than down below in the troughs. Because they looked like radioemitting stars, they were dubbed "quasi-stellar radio sources," which was shortened to quasars. Sunspots are cooler and darker than the rest of the
photosphere and are caused by magnetic fields that impede hot gases from rising to the surface. 4.6 Fast-Moving Projectiles—Satellites EXPLAIN THIS What does Earth's curvature have to do with Earth satellites? When acceleration is downward, the force supplied by the athlete is less. Most ellipticals are small, consisting of fewer than a billion stars
(Figure 27.24). VIDEO: Transverse vs. This is commonly called a flame test and is used to test for the presence of an element in a sample. Mark the poles, either N or S. This gives rise to the relatively weak induced dipole-induced dipole attraction, illustrated in Figure 15.39. Cleavage and Fracture (a) (b) FIGURE 20.8 A mineral's cleavage is very
useful in its identification. (Note that we don't need to know the velocity of the jet to answer this question, but only that it is constant—our clue that acceleration, and therefore net force, is zero.) 3. In a sample of liquid pentane, the molecules are found in all conformations—not unlike a bucket of worms. (a) 80.4 amu (b) 81.0 amu (c) 81.6 amu (d) 64.0
amu (e) 16.4 amu 6. Most common magnets are made from alloys containing iron, nickel, and cobalt, as well as aluminum, in various proportions. In the reaction between nitrogen and oxygen to form nit
molecules possess sufficient energy to react. (CAUTION: Don't try this on your own; even experienced fire walkers sometimes receive bad burns when conditions aren't just right.) The main factor here is the poor conductivity of wood—even red-hot wood. A transformer allows the device to be powered from a 120-V outlet. Members have pledged to
manufacture their products without causing environmental damage. Earthquakes become steadily deeper and deeper in the direction of subduction (Figure 21.25). When the temperature of the reactants is increased, the number of reactant molecules possessing sufficient energy to pass over the barrier also increases, which is why reactions are
generally faster at higher temperatures. Emission of Radiant Energy Every object at any temperature emits radiant energy, spread over a range of frequencies (Figure 7.13). A diver does this by orienting his or her body so more air is encountered—by spreading out like a flying squirrel. The addition of any color to its opposite color results in white
Why is the magnetic field strength inside a currentcarrying loop of wire greater than the field strength about a straight section of wire? Carbon-13 has a mass of 13.0034 amu and makes up 1.11% of naturally occurring carbon. The long cannon imparts a greater impulse because the force acts over a longer time. Only when the quantity of gas is very
large, such as in Earth's atmosphere or a star, do the gravitational forces limit the size or determine the shape of the mass of gas. (Think and formulate your own answer. In a car, the back of the seat pushes you forward. A rock thrown horizontally from a bridge hits the water below. alcohol 6. Don't take our modern-day understanding of the universe
for granted. Glass is transparent to all the frequencies of visible light. The placebo effect, discussed in Section 8.2, can mask the ineffectiveness of various healing modalities. Bernoulli's principle is a consequence of the conservation of energy, although, surprisingly, he developed it long before the concept of energy was formalized.* The full energy
picture for a fluid in motion is quite complicated. The magnetic field also reverses direction. When we say charge to the other. Hydrogen attracts only one additional electron, and so it forms only one covalent bond. This
concentration of ordinary matter at the center of the clump allowed for the formula for the ionic compound magnesium chloride? It is standard practice when doing such calculations to assign a plus sign to energy absorbed and a minus sign to energy released. Which person has the greater terminal speed? The
zinc strips shown here are attached to the hull's exterior surface. Lack of clean drinking water is one of the world's leading causes of death, especially among children of developing nations. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N ) 87. Their edges are well defined (not diffuse), which suggests they are a fairly recent occurrence,
perhaps F I G U R E 2 7. It is said that a gas fills all the space available to it. Hence the accumulation of snow on the lighter mailboxes. (A scanning probe microscope merely shows the positions of atoms and not actual images of atoms, which do not have the solid surfaces implied in the scanning probe image of Figure 12.19b.) So, rather than
describing the atom with a physical model, chemists use what is known as a conceptual model, which describes a system. Like gravity, the "strength" of the spray obeys the inverse-square law. Minerals crystallize from coolFirst ing magma in a systematic fashion, based on their respective melting points. Einstein later remarked that his own failure to
predict a dynamic universe was the "greatest blunder of his life." Subsequent workings of Einstein's equations showed that a static universe would not be stable. This is an expression of chance, meaning that there is a 70% chance that rain will fall somewhere in the forecast area. The cost of transporting the calcium carbonate, coupled with the need
to monitor treated water systems closely, limits liming to only a small fraction of the vast number of water systems already affected. These ideas were completely turned around in the 17th century by Galileo, who held that experiment was superior to logic in uncovering natural laws. Reactions in which there is a net release of energy are called
exothermic. How about if you stand with more of your weight on one foot than the other? Your friend does twice as much work (4d * half the force 7 d * the same force). Show that the specific heat of the rock sample is 800 J/kg # °C) is 13.3
million years. Bubbling carbon dioxide into water causes the pH of the water to go down (become more acidic) because of the formation of carbonic acid. Does the generator at a power station produce dc or ac? hen this page is illuminated by sunlight or lamplight, electrons in the atoms of the paper are set into vibration. (a) Mixing 150 g of sucrose in
100 mL of water at 20°C produces an unsaturated solution. This would have had at least two major consequences. Most of the erupted lava is andesitic, and therefore twice the amount of matter, mass, and weight. This change induces voltage,
which sounds an alarm. 21 Because of refraction, a submerged object appears to be nearer to the surface than it accurate analysis. 10.7 Interference EXPLAIN THIS In what way can both sound and light be canceled? (This demonstration nicely underlies the
condensation cycle of a steam engine—perhaps something for future study.) CHECKPOINT Place a dish of water anywhere in your room. The waves it creates are concentric circles because wave speed is the same in all directions. d, 6. Raising the temperature of 10 kg of steel by 1°C takes 10 kg(450 J/kg # °C) = 4500 J. Lifting condensation level The
height at which rising air cooling at the dry adiabatic rate becomes saturated and condensation begins. 1915. 41 b B (a) The streamlines are the same on either side of a nonspinning baseball. Those that leave (evaporate) are gainers, while losers remain behind and lower the temperature of the water. Both balls have the same range (see Figure 4.19)
If any slight power losses due to heating of the core can be neglected, then Power into primary = (voltage * current) secondary FIGURE 9.34 A common neighborhood transformer, which typically steps 2400 V down to
240 V for houses and small businesses. How many grams of water, H2O, and propene, C3H6, can be formed from the reaction of 6.0 g of 2-propanol, C3H8O? 0 2 F I G U R E 5.1 2 A 3-kg block weighs more in air than it does in water. It is like the bug, which, once it has passed its wave barrier, finds the medium ahead relatively smooth and
undisturbed. Methane, CH4 In looking at the stick structures, remember that each corner or end represents a carbon atom must be bonded four times. Each chapter material. Then we realized that Earth was just a planet orbiting the Sun, which itself was a
medium-sized star among many. 1.0 m ©d 35. Why doesn't the force of gravity change the speed of a satellite in circular orbit? An individual atom is smaller than the wavelengths of visible light and so is unable to reflect that light. Molecule c is a salt consisting of ions, which are nicely soluble in water. What products are formed upon the reaction of
benzoic acid with sodium hydroxide, NaOH? Graphite also glides easily when it is stroked onto paper, leaving a mark—hence its use in pencils. (b) is without a means of proving it wrong and is therefore not a scientific hypothesis. Question. If you hold the stick horizontally, you will have a version of Figure 4.16. For any endothermic reaction, energy
can be considered a reactant and is thus sometimes included before the arrow of the chemical equation: Energy + N2 + O2 h 2 NO In an endothermic reaction, the potential energy of atoms in the product molecules is higher than their potential energy of atoms in the product molecules.
cement" holding the atomic nucleus together. How did he know? What is your own mass in kilograms? The reaction for the ammonium ions is \leq 2NH4+(aq) + 2e- h 2NH3(g) + H2(g) = u Reduction Graphite rod (cathode) eu An electrode is any material that conducts electrons into or out of a medium in which electrochemical reacPaste tions are
occurring. No; smaller quakes—foreshocks—often precede the main quake. Rather than memorizing key terms with a set of flash cards, you will serve yourself far better by first focusing on the underlying concept each term represents. R E A D I N E S S A S S U R A N C E T E S T ( R AT ) If you have a good handle on this chapter, if you really do, then
you should be able to score 7 out of 10 on this RAT. Its gain in KE will equal its decrease in PE, 10 kJ. How does density relate to elasticity? TUTORIAL: Functional Groups The chemistry becomes extraordinarily interesting. List the steps
of the classic scientific method. What else do fuel cells produce besides electricity? In a cloud chamber, moving charged particles show a trail of jet planes high in the sky. By this time our Sun will have exhausted almost all of its nuclear fuel, so this is not something we
Earthlings will be around to witness. This compound is a corrosive, pungent, highly toxic gas—very different from either ethane or ethanol. 366 PARTTWOCHEMISTRY READINESS. This compound is a corrosive, pungent, highly toxic gas—very different from either ethane or ethanol. 366 PARTTWOCHEMISTRY READINESS.
you wonder how a rain puddle dries up, how a car acquires energy from gasoline, or how your eat, you are again thinking about chemistry. The moment when you can seriously damage your eyes if
you continue to look.* At that moment you have entered the penumbra, where the eclipse is partial. When you arise each morning, you measure your height again and consistently find that you are 1 inch taller than you were the night before but only as tall as you were 24 hours ago! Is what happens to your body in this instance best described as a
physical change or a chemical change? One side of Earth would have constant light, and the other side would have constant dark. The ball leaves the thrower's hand at 30 m/s. Silicon has a great affinity for oxygen. Winters/Photo Researchers, Inc. 84 Po S 82 Pb + 2He 2. It may be overThe weight of an apple depends on whelmed by the gravitational
influences of nearer and/or more massive bodies, its distance from Earth's center. It springs from the principles of physics, and it serves as the foundation for the most complex science of all—biology. (If you touch this conducting wire, you won't be shocked, but the wire will heat quickly and may burn your hand!) 198 PA R T O N E P H Y S I CS H I S
T O RY O F 110 VO LT S as a gas lamp. Position a lamp (representing the Sun) in another room near the doorway. If so, what? Surface water erodes rocks and sediments and transports them from their original locations. Correct your friend who says, "The proposed California Suntrain can easily round a curve at a constant velocity of 160 km/h." D I S
C U S S I O N Q U E S T I O N S (E VA LUAT I O N ) 93. Over a thousand exoplanets have so far been discovered. A red piece of glass appears red because it absorbs colors of white light except red, so red light is transmitted. F I G U R E 4 .1 8 45 m 20 m 5m 1s 2s 3s CHECKPOINT 1. Slate, which is metamorphosed shale, is a foliated rock composed
of very small particles and tiny mica flakes. As he splashes into the water, this kinetic energy is spread to make the water molecules move faster and heat up just a little. Briefly, each subatomic particles can share the same quantum state. Are these forces equal and opposite? What is the speed
of the collision? Can you see that the two slabs of lithosphere are on different plates? The principal lifting mechanisms are (a) convectional, orographic, and frontal lifting. The impulse is greater if her hand bounces back from the bricks upon impact. This kind of momentum is linear momentum. 0 C 64. Cosmic rays produce ions in air, which offer a
conducting path for the discharge of charged objects. Work is required to elevate objects against Earth's gravity. 5.5 Pressure in a Gas E X P L A I N T H I S Why is holding your breath a no-no for scuba divers ascending to the surface of the water? This is an example of the greenhouse effect, so named for the same temperature-raising effect in
florists' glass greenhouses. 20 Although the solubilities of many solid solutes— sucrose, to name just one example—are greatly in 20 creased by temperature increases, the solubilities of other solid solutes, such as sodium chloride, are only mildly affected, as Figure 16.20 shows. Sometimes true and sometimes false! Within any one period of the
periodic table, it is true that electronegativity increases with increasing nuclear charge. The graph slopes upward with increasing atomic number as expected: elements are more massive as atomic number as expected: elements are more massive as atomic number increases. On a clear evening after sunset, several planets can often be seen in the western sky forming a line that points directly toward the Sunset increases.
Interesting crystals can also be made from supersaturated solutions of Epsom salts (MgSO4 # 7 H2O) and alum (KAl(SO4)2 # 12 H2O), which is used for pickling and is available in the spice section of some grocery stores. Chemistry author John, who in his "other life" is John Andrew, singer and songwriter, plays his guitar on page 227. Would it be
easier to push or pull a wheelbarrow over a step? What happens if the buoyant force decreases? While bombarding a sample of uranium with neutrons in the hope of creating new, heavier elements, they were astonished to find chemical evidence for the production of LEARNING OBJECTIVE Describe the process by which large atomic nuclei can split
in half, leading to the production of energy. Therefore Earth travels faster around the Sun in December than in June. The main difference between the site of magma generation and Earth's surface. While the submarine is floating, its buoyant force equals its weight.
Zinc cup (anode) Zn(s) h Zn2 + (aq) + 2e- Oxidation The reduction of ammonium ions in a dry-cell battery produces two gases—ammonia, NH3, and hydrogen, H2—that need to be removed to avoid a pressure buildup and a potential explosion. FIGURE 10.38 A shock wave. Component K will push the boat along in a forward direction, angling into the
wind. Breeding occurs to some extent in all fission reactors, but a reactor specifically designed to breed more fissionable fuel than is put into it is called a breeder reactor. Minerals with lower amounts of silica crystallize first. Fish depend on this oxygen to survive. Each carbon-containing organic compound has its own set of unique physical, chemical
and biological properties. So when the bird drops from the branch, its initial sideways motion remains unchanged. A child who 1 N here weighs 300 N at sea level weighs only 299 N atop Gravitational force ~ 12 Mt. Everest. All ionic compounds are completely different from the elements from which they are made. As shown in Figure 17.6, initially a
flask may contain only reactant molecules. A neutron seems to need protons around to keep this from happening. Drifting in deep space, you would remain weightless because no discernable force acts on you. What would happen if their tangential velocities were reduced to zero? The answer may be waiting for us in our own galactic backyard.
Benzaldehyde is a fragrant oil. These solids are further refined for commercial sale. They are strong enough to hold sheets of paper on a refrigerator door, but they have a very short range because the north and south poles cancel a short distance from the magnetic surface. As you pour water into a glass, you repeatedly tap the glass exterior with a
spoon. (a) sodium ions, hydroxide ions, and water (b) sodium ions, hydroxide ions, and hydronium ions (c) sodium ions and hydronium ions (d) sodium ions and water 4. 2 PROLOGUE T H E N AT U R E O F S CI E N CE LEARNING OBJECTIVE Acknowledge contributions to science by various cultures. By analogy, imagine you're standing next to a
railroad track watching a train coming toward you at a constant 100 mph. How is the strength of a magnetic field in a coil affected when a piece of iron is placed inside? (b) The reaction should be cooled down. ©KE = Fd = (50 N)(20 m) = 1000 J. The greater pressure inside the roof can lift it off the house. Iridium, a hard, brittle, silvery-white metal in
the platinum family, is the densest substance on Earth. For a monaural signal, this means that when one speaker is sending a compression of sound, the other is sending a compression of sound, the other is sending a compression of sound, the other is sending a rarefaction. Rank, from beginning to end, the stages in the formation of a cold front: (a) warm air is forced upward where it cools; (b) air cools and sinks, pressure rises, rain stops;
(c) formation of cumulonimbus or nimbostratus clouds; (d) thunderstorms with heavy showers and gusty winds. When we consider the time it takes for a pendulum to swing to and fro, we're talking about the pendulum's (a) frequency. As a result, ethanol and water readily mix with each other. The whirling blades are shaped to force air particles down
(action), and the air forces the blades up (reaction). In this chapter, we will explore both the nature of atoms and their electrons, and stars and their planets, for example, are in a state of
perpetual motion. 538: (a, b) Shutterstock 538: (c) Dorling Kindersley 540: (top) Dr. Rob Stepney/SPL/ Photo Researchers, Inc. A A B C 67. River-deposited rocks tend to be more sorted and more rounded. The nucleus is a relatively heavy particle that makes up most of an atom's mass. The transmission of sound requires a medium. For example,
Actual path INTERACTIVE FIGURE In the presence of air resistance, the trajectory of a high-speed projectile falls short of the idealized parabolic path. As the various components begin to condense. The air above the smoke is warmer than the smoke, and the air below is cooler. Only occasionally, one or two
times a year or so, does a neutrino or two interact with the matter of your body. (c) both of these (d) neither of these 6. For larger urban areas, where open land is scarce, In 1908, Jersey City, New Jersey, became the first American city to begin chlorinating its drinking water. (c) How does the work done compare with the increased potential energy of
the load? (b) Because gasoline is a very polar molecule, the salt can form only dipole-induced dipole bonds, which are very weak, giving it a low solubility in gasoline is a very polar molecule, the salt can form only dipole-induced dipole bonds, which are very weak, giving it a low solubility in gasoline. The filings trace out a pattern of magnetic field lines in the surrounding space. Rank their speeds from fastest to slowest. Then look at a plain white surface. These, in turn, vibrate
against neighboring molecules, which, in turn, do the same, and so on. This is similar to radioactive atoms. By the 1840s, studies of the most recently discovered planet at the time, Uranus, showed that the deviations of its orbit could not be explained by perturbations from all other known planets. The curvature of four-dimensional spacetime (three of
distance and one of time) can be expressed mathematically, but is rather impossible for us to visualize. "A calculator is useful but certainly not exciting." Why would someone from 100 years ago vehemently disagree with this statement? Condensation is the opposite of evaporation. So phase changes 20 depend on pressure as well as temperature.
These isotopes, and certain lighter radioactive isotopes, emit three distinct types of radiation, named by the first three letters of the Greek alphabet, a, b, g— alpha, beta, and gamma. In which atmospheric layer does all our weather occur? The conversion of neutrons into protons, however, releases energy at lower temperatures in accordance with the
second law of thermodynamics. model of a fluorine molecule, the When writing electron-dot structures for covalent compounds, chemists often spheres use a straight line to represent the two electrons involved in a covalent bond. F I G U R E 1 5 .1 0 Two aluminum atoms lose a total of six electrons to form two aluminum
ions, Al3+. What is the primary difference between a chemical bond and an attraction between two molecules? EXPLAIN THIS I n three regions of our solar system, we find the remains of material that failed to collect into planets. After saturation, the moist adiabatic lapse rate controls how thick the cloud becomes. What prevents rainbows from
being seen as complete circles? (a) Grape juice turns to wine. This has bolstered scientists' faith that the ultimately correct description of nature involves conciseness of expression and economy of concepts—a supposition that has not
been verified. Avoid the steam produced in this activity—steam burns can be particularly harmful. (a) removing the impure water molecules (b) removing the impure water molecules (b) removing the impure water molecules (b) removing the impure water molecules (c) breaking down the water to its simplest components (d) adding some disinfectant such as chlorine Was this your answer? Dave Vasquez with his family are barely
seen in the solar-powered train on page 81. Figure 19.5 shows the octane information that appears on a typical gasoline pump. 149 Hot stove FIGURE 6.7 6.4 Quantity of Heat EXPLAIN THIS Which is the largest: 1 calorie, 1 Calorie, or 1 joule? We see that there is a limit to the size of the atomic nucleus. 1 Mineral Talc Gypsum Calcite Fluorite Apatite
Feldspar Quartz Topaz Corundum Diamond The physical properties of a mineral all relate back to the mineral's chemistry. FIGURE 28.5 This all-sky map of the cosmic background radiation taken by the Wilkinson Microwave Anisotropy Probe (WMAP) satellite reveals an average temperature of about 2.73 K everywhere. Potential Energy F I G U R E 3
.1 7 The potential energy of Tenny's drawn bow equals the work (average force * distance) that she did in drawing the bow into position. An example of a gaseous solution is the air we breathe. Show that the acceleration of a car that can go from rest to 100 km/h in 10 s is 10 km/h # s. Energy is consumed by an endothermic reaction. You can balance
unbalanced equations by adding or changing coefficients to produce correct ratios. They pass through each other, but then gravity tugs them back into a single irregular galaxy, which eventually transforms into an elliptical galaxy. More than one person has been killed by close-range firing of blanks. Normal The law of reflection is illustrated with
arrows representing light rays in Figure 11.10. Complete the following nuclear reactions: ? The answer is yes, as you will now see. In this chapter, we explore two main classes of chemical reactions: and descends beneath another plate at
a convergent boundary. When you run into the direction of the downpour, the drops strike you harder and more frequently, but when you run away from the direction of the downpour, the drops don't strike you as hard or as frequently. This repulsive force causes the alpha particle to accelerate to high velocities as it moves away from the nucleus.
Communications system failures, power blackouts, and brownouts are often attributed to space weather. A gain of electrons creates a negatively charged ion. * But appeal to beauty has value in science. In British units, the average atmospheric pressure at sea level is 14.7 lb/in2 (pounds per square inch, or psi). If the distance from the core to the
outer edges was 50,000 light-years, how much surface area are you looking at? (Neglect air resistance.) 67. Class Performance on Assignment Click on a problem to see where your students struggled the most and their most common wrong answers. To gain a better understanding of the bending of light in refraction, look at the pair of toy cart wheels
in Figure 11.17. rotate in a (a) clockwise; Coriolis force (b) counterclockwise; Coriolis force (c) clockwise; cyclogenesis force (d) counterclockwise; cyclogenesis force (d) counterclockwise; cyclogenesis force (e) clockwise; cyclogenesis force (e) clockwise; cyclogenesis force (f) counterclockwise; cyclogenesis force (f) cyclogenesis force (f) cyclogenesis forc
molecules. Add a couple tablespoons of sugar to the empty glass. C, A, B, D. What do we call two colors that add to produce white? A third level of treatment is expensive, and not all communities are in locations where this level of wastewater treatment is expensive, and not all communities are in locations where this level of wastewater treatment is expensive, and not all communities are in locations where this level of treatment is expensive.
fuel consumed by the air conditioner. Recall from Section 8.6 that energy is released when molecules come together to form a solid (the heat of freezing). In what sense is Pluto a potential comet? When these regions themselves are aligned with one another, the substance containing them is a magnet. EXPLAIN THIS We live at the bottom of an ocean
of air. Every year these fuels are turned to heat, smoke, and megatons of poisonous gases such as sulfur oxides. I didn't know the answer until more than a year later, when Burl's stimulation resulted in my leaving full-time painting and going to college to learn more about science.* There I learned that any object at rest, such as the sign-painting
scaffold I worked on with Burl, is said to be in equilibrium. Nature 9 clearly follows mathematical rules! Investigate Figure A.2 carefully and note the total distance covered as the ball accelerates down the plane. lectrical forces, can act between things that are not in contact with each other. Then there would be no tension in
that rope. 98. Throughout the history of life on Earth, there have been at least six major mass extinctions. What other form of energy is involved, and how much? Rain or snow is most likely to be produced by which of the following cloud forms: (a) cirrostratus, (b) nimbostratus, (c) altocumulus, or (d) stratocumulus? The surface of the soap is scratched
in the direction it is rubbed. Acceleration occurs because the vehicle's direction is changing. If a part of the lane were cut away, the ball would not below. No single form of energy such as KE need be conserved. The more luminous a star, the brighter it appears. Among his teaching innovations was the idea of
providing students with problem sets as a follow-up to lectures and readings. Drift A general term for all glacial deposits. The structure of the physics and chemistry a new section on nanotechnology was added in Chapter 14. Would a bimetallic strip of two different
metals function if each metal had the same on a larger scale on page 144 is P. These are the primary scatterers of lower-
frequency light. Average speed = = 2 m/s. The mass of 2 moles of NO is SAM PLE PROBLEM 3 How many grams of ozone (O3, 48 amu) in the reaction below? Charged particles moving through a magnetic field are deflected most when they move at right angles to the field lines, and they are
deflected least when they move parallel to the field lines. Also note that, for reasons explained later, the sixth and seventh periods each include a subset of elements, which are listed apart from the main body. (c) The slow reaction must have a low activation energy, while the fast reaction must have a low activation energy. If we know the relative
masses of different materials, we can measure equal numbers. Acceleration, we produce the exact equation: net force Acceleration = mass In briefest form, where a is acceleration, F is net force,
and m is mass: F a = m Acceleration equals the net force divided by the mass. Although violet light is scattered more than blue, our eyes are not very sensitive to violet light. Hewitt 286: (top) Diane Schiumo/Fundamental Photographs, NYC 286: (bottom a, b, c) Paul G. The heavy lines on a weather map represent fronts. When there are too few water
molecules to dissolve any additional sucrose, the solution is saturated. (c) Faraday's law. What coefficients balance this equation? (Make sure your answer is consistent with the equation for Newton's second law.) 102. With a compass you can see that cans of food on your pantry shelf have north and south poles. How is municipal water treated so that
it's safe enough to pipe into our homes for consumption? Which is a liquid and which is a gas at 80 K (-193°C)? How about if it gallops 50 m in 4 s? CHAPTER 20 R O CK S A N D M I N E R A L S 533 Were these your answers? What is the relationship between saturation vapor pressure and humidity? Recently, the commercial use of lanthanides has
increased. Which process would release energy from gold: fission or fusion? The same applies to vessels in air. (b) Spirit took photographs in June 2004 for this composite, true-color image of the region named Columbia Hills on Mars. A species of worm thrives in the glacial ice in the Arctic. As we continue to look at the natural universe with ever
more powerful telescopes, we can expect that our speculations will become ever more refined. According to momentum of both carts stuck together afterward. Should you connect them in series or in parallel? To begin your wingsuit flight, you step off the edge of a high
cliff. (a) Diamond (b) Graphite FIGURE 20.7 Both graphite and diamond are pure carbon. FYI CHECKPOINT The energy of a diver diving into a pool is dispersed as lots of moving water and a little heat after the diver hits the water. The questions are categorized according to level of difficulty. Sedimentary rocks Rocks formed from the accumulation of
weathered material (sediments) that has been eroded by water, wind, or ice. (c) A, B = D, C. In order for two chemicals to be able to react, they must first collide in the proper orientation. Just the slightest push this way or that would cause it to either collapse or expand. FIGURE 5.26 Strictly speaking, they do not suck the soda up the straws. An
electron's wave nature can be used to explain why electrons in an atom are restricted to particular energy levels. Many, if not most, practicing organic chemists dedicate much of their time to the synthesis of organic molecules that have practicing organic chemists dedicate much of their time to the synthesis of organic molecules that have practicing organic chemists dedicate much of their time to the synthesis of organic molecules that have practicing organic chemists dedicate much of their time to the synthesis of organic molecules that have practicing organic chemists dedicate much of their time to the synthesis of organic molecules that have practicing organic chemists dedicate much of their time to the synthesis of organic molecules that have practicing organic chemists dedicate much of their time to the synthesis of organic chemists dedicate much of their time to the synthesis of organic chemists dedicate much of their time to the synthesis of organic chemists dedicate much of their time to the synthesis of organic chemists.
the other. Ice, water, and rocks have mass, and as they move around, they exert a change on Earth's mass balance. (a) Rank the current through each part, from greatest to least. Only frequency and wavelength change in the Doppler effect, not wave speed. Atmospheric gases (mainly water vapor and carbon dioxide) absorb and re-emit much of this
long-wavelength terrestrial radiation back to Earth. d 7.86 * 108 m Rearranging d = vt, we have t = = 2.56 s. At increasing distances, lithosphere is progressively thicker and older—equally on both sides of the ridge. The energy given off by rock at Earth's surface transfers to the surroundings practically as fast as it is generated. Now suppose 3 red
and 2 black pieces are removed to form the first "mineral." Now 9 red and 10 black pieces remain in the "liquid," which is now represented by only 19 checkers. A common galvanometer design. The few fast-moving reactant molecules in Figure 17.12 have enough energy to pass over the energy barrier and are the first to transform to product
molecules. How about a reaction that takes only fractions of a second? This process requires sufficient vertical development of the cloud; otherwise, there are not enough droplets to grow big CHAP TER 25 TA B L E 2 5. If everything pulls on everything else, then the planets must pull on each other. No water leaks
from inside the unit because water vapor in warm air condenses on its low-temperature metal surface. Glass is transparent to shortwavelength radiation but opaque to long-wavelength radiation. Zoned sequences of minerals are also characteristic of regional metamorphism. Granite rock The environmental impact of acid rain depends on local
geology, as Figure 18.14 illustrates. The heat of vaporization for water Lv is 540 cal/g. For example, when you throw a baseball, the force of gravity, air friction, and the pushing force you apply with your muscles all act on the ball. One of the more commonly used plasticizers is the phthalates, some of which have been shown to disrupt the
development of reproductive organs, especially in the fetus and in growing children. Dust tail is pushed by sunlight. Such water is appropriately called "heavy water," which has the formula D2O. With each time, it makes more sense. This is true whether the current is externally produced or produced as a result of the induction that accompanies the
motion of the wire in the field. In terms of momentum conservation, since no external forces act in the horizontal direction, the momentum before. Regional metamorphism is associated with compressive stress and mountain building. Furthermore, the transverse waves cannot travel through liquid
matter, while the longitudinal waves can, which provides a means of determining whether matter below ground is molten or solid. Which elements have the greatest tendency to behave as oxidizing agents? This longer wavelength means a lower frequency, which for visible light means a shift toward the red end of the color spectrum. Many
municipalities also require a third level, a tertiary level, of wastewater treatment. From the expression watts = amperes * volts, we can see that current = 1200 W/120 V = 10 A, so the hair dryer will operate when connected to the circuit. Salt An ionic compound commonly formed from the reaction between an acid and a base. By convention, acid rain
is a term used for rain with a pH lower than 5. Even so, the many variables involved often impede the making of accurate predictions; so don't count on an absence of rain on your parade! For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Adiabatic A term that describes temperature
change in the absence of heat transfer; expanding air cools and compressing air warms. Check Figure 11.33 to see if the following three statements are accurate. Problem Solving We're asked for horizontal speed, so we write SAM PLE PROBLEM 1 A ball of mass 1.0 kg rolls off of a 1.25-m-high lab table and hits the floor 3.0 m from the base of the
table. But alas, an electric current is This side immediately not sustained by this arrangement. Exercises (Synthesis) The Exercises, by a notch or two, are the more challenging questions at the end of each chapter. They are simply light enough for the buoyancy to be significant. Michelson sent a beam of light from a revolving mirror to a stationary
mirror 15 km away. During this brief time of abundant energy, the heavy CHAP TER 27 elements beyond iron are synthesized, as protons and neutrons outside the core mash into other nuclei to produce such elements as silver, gold, and uranium. This is because as the boat travels faster, the impact of wind is increased. Calcium chloride, CaCl2, is
commonly used to de-ice walkways, and sodium fluoride, NaF, helps prevent tooth decay. Because such arithmetic exercises are not really physics, we won't be concerned with these conversions (perhaps important in a math class, but not here). ow much current is in a circuit depends not only on voltage but also on the electrical resistance of the
circuit. Add an acid, and the water will react with that acid to produce more hydronium ions. The likely source is ongoing residual volcanic activity, which could potentially melt underground ice into liquid water. This differential spin means the surface near the equator pulls ahead of the surface farther north or south. (Here our parallelogram is a
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rectangle.) Then draw a diagonal from the origin of the vector pair; this is the resultant (Figure B.3). He wonders what the approximate size of such a balloon would be. The internal order of halite crystals is reflected in its macroscopic mineral grains. 152 PA R T O N E P H Y S I CS FIGURING PHYSICAL SCIENCE Problem Solving SAM PLE
PROBLEM 2 SAM PLE PROBLEM 3 If the specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance, then the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat transferred = specific heat capacity c is known for a substance of the heat capacity c is known for a substance of the heat capacity c is known for a substa
does a spectroscope do to the light coming from an atom? One-quarter covered? Multiple loops of wire must be insulated, because bare wire loops touching each other make a short circuit. It is common to confuse velocity (which is a rate of change). 20
20 2017 Aug. Although the instantaneous speed and instantaneous velocity have the same value at the same instant, the average speed and average speed average speed and average speed average speed average speed and average speed average spee
a deflecting force due to the motion of the charge: The deflecting force is perpendicular to the welocity of the charge and perpendicular to the magnetic field lines. Convergent boundaries—where plates move toward each other 3. The gravitational forces of these cores were strong enough to sweep up gases of the early planetary nebula, primarily
hydrogen and helium. According to this law, as discussed in Section 4.1, the force of gravity depends on the inverse square of the distance. What consequence awaits a person whose combined work and heat output is less than the energy consumed? Such an air parcel expands as it rises, becoming cooler. A force F acts in the forward direction on a
carton of chocolates of mass m. Furthermore, ultraprecise experiments here on Earth have shown that time runs slower at the bottom of a tall tower, than at the top of the tower. Use a magnifying glass to examine closely the screen of a computer monitor or television set. The wood melts more ice because its higher specific heat capacity means it
releases more energy in cooling. 3 Heat 6. Since plate boundaries are typically long, the mountain ranges that form near them are long. The exercises, rankings, and problems are extra "pushups" for you to try after you have at least a fair understanding of the chapter and can handle the reading check questions. How might you separate a mixture of
sand and salt? C H A P T E R 10 Microphone can afford high-end speakers for your home theater system, you Wavelength may not be disturbed. A boxer can hit a heavy bag with great force. Without the nuclear strong force there would be no atoms beyond
hydrogen. Huge, gaping cracks called crevasses may develop in this surface ice. When it travels at the same speed on the Moon, is its momentum greater, less, or the same? Which, if either, requires more work: lifting a 50-kg sack a vertical distance of 4 m? Looking up, an unusually smart ant may see
the curved horizon and conclude that its environment is highly curved. It accomplishes this by attracting opposite charges to it and repelling like charges to it and repelling like charges to parts of the door farther away. The reason spaghetti is cooked in vigorously boiling water is simply to ensure that the spaghetti doesn't stick to itself and the pot. Fish don't live very long in water
that has just been boiled and brought back to room temperature. For d very great distances, Earth's gravitational force approaches zero. Baseball games normally take place on 30 m/s 30 m/s level ground. This is how coffee is often made: the caffeine and flavor molecules in the hot water pass through the filter and into the coffeepot, while the solid
coffee grounds remain behind. The Responsible Care program emblem is shown in Figure 14.3. If we use chemistry wisely, most waste products can be minimized, recycled, engineered into salable commodities, or rendered environmentally benign. The partial melt differs from the original rock because it is richer in silica. (a) Why doesn't the tension
force in the string do work on the pendulum? Overlapping at the edges occurs only when the bug swims faster than wave speed. In this way, \boxtimes F = 0. Does a solar eclipse occur at the time of a full Moon or a new Moon? Rather than falling into the black hole, some of the charged particles, such as electrons, are accelerated outward through these
magnetic fields to nearly the speed of light. Lil's mom Siu Bik and dad Wai Tsan Lee are on pages 179 and 220, and Lil's niece Allison Lee Wong are on pages 176. The force that controls Jupiter, for example, is not just the force from the Sun; there are also pulls from the other planets. If you saw the label phenylephrine HCl
on a decongestant, would you worry that consuming it would expose you to the strong acid hydrochloric acid? These men suffered the genetic disease hemochromatosis, excess iron in the blood (women were less afflicted partly due to menstruation). The stars remain relatively fixed in their patterns in the sky, but the planets wander. 10.5 Reflection
and Refraction of Sound 11. Saturated solution of sucrose in water at 20°C Component Sucrose water as there are about 10 g of sucrose is twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as massive as 100 g of sucrose in twice as 100 g of sucrose in tw
200 g of sucrose. Can you see that the Sun is a roughly average mainsequence star in terms of its luminosity and temperature? In winter months, the ocean water is warmer than the air. Better hypotheses are made by those who are honest in the face of experimental evidence. From a point of view outside the wagon, the ball stays in place as the back
of the wagon moves toward it. The device then resonates to one station at a time, instead of playing all stations at once. Let's look at how the elements are grouped as metals, nonmetals, and metalloids. (a) How do the forces acting on the elements are grouped as metals, nonmetals, and metalloids.
red. Lakes lying in silicon dioxide, SiO2, containing granite basins tend to become acidified by acid rain more readily than lakes lying in calcium carbonate, CaCO3, limestone basins. The HCl would react with the free base to form the water-soluble, but diethyl ether-insoluble, hydrochloric acid salt of caffeine. If you haven't yet formulated an answer,
why not back up and reread the question? (a) The skipper notes that 15 m of wave pass each 5 s or, equivalently, 3 m pass each 1 s, so speed = distance/time = (15 m)/ (5 s) = 3 m/s. Uranus has at least 27 moons, in addition to a complicated faint ring system. Instead of lava, Titan has a flowing slush of ice and liquid ammonia. It is a vector quantity. In
certain isotopes of uranium, however, this domination is tenuous. They occur (are induced) only when they are in close proximity to a water molecule or another dipole. Another way to look at this is: The OH bond is a polar bond and this is what is needed to allow for good solubility in water. There is no way to "transform" momentum S-4 O D D - N U
M B E R E D S O LU T I O N S from one form into another, so it is conserved. So why are we more out of breath after running upstairs in a few minutes? It has one of the highest rotational speeds of any pulsar studied, rotating more than 30 times per second. A more detailed analysis shows that the amount
of helium created just after the Big Bang should be about that which we observe in the universe today. What is the weight in newtons of this amount of air? When you rub your hands together, can you push harder on one hand than on the other? In the case of objects in free fall, it is customary to use the letter g to represent the acceleration instead of
the letter a (g because acceleration is due to gravity). Reconcile this fact with Newton's first law, which states that motion with a constant velocity indicates no force. Relate the shape and sorting of sand particles to the way in which they were most likely transported. Wherever there is a spreading of energy, there is a corresponding increase in
entropy. 6.1 Temperature EXPLAIN THIS What are two temperatures for ice water? (b) altering the orbits of our planets. Opponents complained that Wegener failed to provide a suitable driving force to account for the continental movements. In which atomic nucleus do nucleons have the least mass? S TA R S A N D G A L A X I E S A star's life cycle
depends on its mass. Solar energy is generated deep within the core of the Sun. Gracie says acceleration is how fast you go. The electrical signals pass through a coil wound around the neck of a paper cone. The ignition of nuclear fuel marks the change from protostar to star. (a) (b) CHAPTER 3 MOMENTUM AN D ENERGY 65 Case 3: Decreasing
 Momentum Over a Short Time When boxing, if you move into a punch instead of away, you're in trouble. Al Rb. A black hole is a collapsed supergiant. Could you move off to one side and then see the rainbow as the segment of an ellipse rather than the segment of a circle (as Figure 11.47 suggests)? The force is the wall pushing back on your fingers.
Can you explain your observations? Assume that the pulleys and string are massless and there is no friction. When the air pressure inside a cylinder like that shown in Figure 5.21 is reduced, an upward force is exerted on the piston. The higher the temperature of a material, the faster its molecules move and the more forceful the collisions between
them. For more practice balancing equations, see the questions at the end of this chapter. Show that the lift on the air cools to its dew point, the relative humidity climbs to 100%, water vapor condenses, and clouds form. This air has a weight of about 10 N. Suppose you stood on top of a ladder that was so tall that you were
three times as far from Earth's center as you presently are. Once these charges have been assigned, we can see the most fundamental rule of electrical behavior: TUTORIAL: Electrostatics Charge is like a baton in a relay race. A stick structure is a commonly used shorthand notation for representing an organic molecule. It sorts out the complex
jumble of air pulsations that reach it, and it transforms them into pure tones. 5 8 Light is transmitted when the axes of the Polaroids are aligned (a), but absorbed when Ludmila rotates one so that the axes are at right angles to each other (b). When both eyes are open, one eye "fills in" the part to which your other eye is blind. What might we assume
 about the distribution of dark matter if the planets in our solar system all orbited the Sun at about the same speed? (c) density of fluid. By what specific means do the bits of fine threads align in the electric fields in Figure 8.11? Larger particles are unaffected by sunlight or solar wind. 4 when pressure goes down. Hewitt 227: (bottom) Lillian Lee/Paul
G. 37 The vivid colors of Sneezlee represent many frequencies of light. The amount of uranium has decreased, and the amount of lead has increased (via radioactive decay). Evidence suggests that when the solar system was forming, the asteroid belt held much more mass than it does today. Does the law of reflection hold for curved mirrors?
Whichever indicator you use, note the swirls of color forming at the anode as hydroxide ions are generated. Why are plastics generatly so inexpensive? The answer involves updrafts—the upward movement of air. But knowing the physics helps you understand why hitting a soft object is entirely different from hitting a hard one. They almost did, but the anode as hydroxide ions are generated.
because of air resistance, the heavier one hit a split second before the other. The average pressure at sea level (101.3 kPa) is often called 1 atmosphere (atm). Heat The thermal energy that flows from a substance of higher temperature, commonly measured in calories or joules. When the speakers are far apart,
monaural (not stereo) sound is not as loud as it is from properly phased speakers. The two should neutralize each other so that the color moves toward purple. Look at the trends and you'll see that, in any one period, all atoms to the left are larger than those to the right. North Star In addition to the diurnal motion of the sky, there is intrinsic motion
of certain bodies that change their positions with respect to the stars. Iodine, I2, a solid at room temperature (b) Electrons repel electrons, which means they resist bunching together to one side of the atom. A simple mercury barometer is illustrated in Figure 5.25. From Ft = \mathbb{Q}(mv), F = \mathbb{Q}(
m/s)/2 s = 15 N. Kids can balance a seesaw even when their weights are unequal. Sometimes they are thrown toward the Sun, where the added heat and solar wind cause the ice and other volatile materials to be ejected, always in a direction away from the Sun. Better yet, stretch the rubber band in front of a windy fan to get it vibrating. The same
concept holds for compounds. Hewitt 256: Hu Meidor/Paul G. Those with insufficient tangential speeds are pulled into, and are gobbled up by, the galactic nucleus—usually a black hole. Is this mixing an exothermic or endothermic process? On the ground below is a fat, juicy worm. O... A major source of chlorine gas, Cl2, is the electrolysis of brine,
which is concentrated salt water, NaCl(aq). Minerals are formed by crystallization—the growth of a crystallization—the growth of a crystallization—the growth of a crystallization—the water appears to be still, the water molecules are bustling with kinetic energy. In this case, current branches into three separate
pathways from A to B. Then put one bottle in a freezer and try the procedure again. FIGURE 2.28 Ducks fly in a V formation because air pushed downward at the tips of their wings swirls upward, creating an updraft that is strongest off to the side of the bird. Cavalry troops marching across a footbridge near Manchester, England, in 1831
 inadvertently caused the bridge to collapse when they marched in rhythm with the bridge's natural frequency. An ammonium ion, for example, may donate a hydroxide ion to re-form ammonia and water: 

H≤0 

NH3 

NH3 

NH4 

NH4 

NH4 

NH3 

NH4 

simultaneously and can therefore be represented as occurring at the same time by using two oppositely facing arrows: \ge H20 \le NH3 H \le donor (acid) When the equation is viewed from left to right, the ammonia behaves as a base because it accepts a hydrogen ion from the water,
which therefore acts as an acid. Our is the perfect place to planet is unique in our solar system. A, B, C. Ft = (100 N)(0.5 s) = 50 N # s. To discuss fluids, it is important to introduce two concepts—density and pressure. When the frequencies are identical, the beats disappear. Let's now look at the other extreme of solubility, in which a solute has very
little solubility in a given solvent. It has perfect cleavage—it breaks on all sides, so it always breaks into cubes. When are these forces of equal magnitude, and when are the equal magnitude, and 
of golf balls in 200 g of golf balls equals the number of Ping-Pong balls. The scope of chemistry, therefore, is very broad. Also contributing to its weakness is the wall, which likely is not a perfect reflector. These two forces are equal in magnitude (amount) and opposite in direction. Although the innermost electrons in an atom
are held very tightly to the oppositely charged atomic nucleus, the outermost electrons of many atoms are held very loosely and can be easily dislodged. Each packet is called a quantum. What is true about the relative concentrations of hydronium and hydroxide ions in an acidic solution? Then turn your gaze to a white wall. The change in momentum
of the bug is evident because of its large change in speed. We say that they each have their own configuration, which refers to how the atoms are connected. If suddenly the force of gravity were cut off, what type of path would the shuttle follow? The electric field accelerates the charged particle in its direction, and the magnetic field accelerates it
perpendicular to its direction, causing it to follow a nearly circular path.) 65. Discuss whether or not a sonic boom occurs at the moment when an aircraft exceeds the speed of sound. Thicker clouds give droplets more time and space to coalesce into drops that are heavy enough to fall. Very massive stars have short lives and die in massive explosions
called supernovae. The other half, in accord with conservation of linear momentum, have twice the initial velocity, overshoot the circular orbit, and enter an elliptical orbit whose apogee (highest point) is farther from Earth's center. H2O molecules are electrically polarized, with opposite charges on FIGURE 8.9 INTERACTIVE FIGURE Electric field
representations about a negative charge. This activity nicely shows that water is not a good conductor of heat. Consider further ethylamine, C2H7N, which has a nitrogen atom on the same basic two-carbon framework. The important thing is that they are co-parts of a single interaction and that neither force exists without the other. Follow the ray of
sunlight as it enters the drop near its top surface. A space probe built by NASA and the European Space Agency landed on Titan in 2005. You may recall from our discussion of the periodic table in Chapter 12 that there are 112 known elements, and that many of these elements are rare. Use the equation surface area density = number of stars/surface
area. In a string, the vibration makes a single segment. Similarly, a charged object has potential energy by virtue of its location in an electric field. Religion addresses the source, purpose, and meaning of it all. VIDEO: Ionic Bonds 15.3 Ion
water molecules break the ionic bonds and pull the ions away from one another. A high-pitched sound, such as that from a trillion would take 31,700 years! Counting to a trillion times would take about 2 million times the estimated age of the universe
SAM PLE PROBLEM 3 Solution: Solution: Solution: Solution: 38,401 km 4 30 12,760 km About 30 Earth-sized planets would fit in the distance between Earth and the Moon. DISCUSSION QUESTION ) 93. This means that the current passing through the resistance of each electrical device along the pathway is the same. The time frame
for the Big Rip is estimated to be about 35 billion years after the Big Bang, which would be about 21 billion years from now. Astronomical measurements reveal that about 90% of the mass of the universe is invisible to us. Today, some 53 million gallons of high-level radioactive and chemical wastes are stored in 177 underground tanks, many of them
leaking into the groundwater. This is analogous which three fluorine atoms are oriented 120° from one another around a cento two people in a tug-of-war. Remember, the atoms before and after the arrow in a balanced equation are the same atoms only in different arrangements. An example is aluminum, the third most abundant element in Earth's
crust. Box A shows oval molecules dissolved within smaller circle molecules. This is the liquid phase of matter, and the mobility to flow and to assume the shape of its container. CHAPTER 3 pulls 7 m of rope with a force of 50 N and lifts a load of 500 N through a
vertical distance of 0.7 m. Since power = current * voltage, more power for the same voltage means more current. Knowing about rocks and minerals helps us understand the design and architecture of a building. Science helps
determine the most probable. But how could the pole be in more than one place at the same time? For the planet five times as far, light would be 25 as intense. 20 Oct. Constructive interference results from crest-to-crest reinforcement; destructive interference results from cre
form of an earthquake, or slowly over time. Transmutation occurs in natural events and is also initiated artificially in the laboratory. This relationship applies to all kinds of waves, whether they are water waves, sound waves, or light waves. 2 1 When wet, the cloth covering the canteen promotes cooling. Core The central layer of Earth's interior,
divided into an outer liquid core and an inner solid core. With air resistance, water drops fall at a tolerable terminal speed. As the descending, seawater-saturated plate is pulled downward, it heats up. A jumbo jet cruises at constant 100,000 N. The air pressure in the bag is
greater than the surrounding atmospheric pressure. If stream speed increases, a laminar flow can become turbulent. Does a rain shadow occur on the windward or leeward side of a mountain range? When is your weight equal to mg? These common experiences show that sound requires time to travel from one place to another. (b) Yes. Thus the influx
of microwave radiation that initially puzzled Penzias and Wilson was found to be emitted by the cooling universe itself. What is the ultimate source of geothermal energy? What are the two processes by which rock is changed during metamorphism? Each sucrose crystal consists of billions of sucrose molecules packed neatly together. The two
interpretations of the falling balls are equally valid, and Einstein incorporated this equivalence, or the impossibility of distinguishing between gravitation and acceleration, into the foundation of his general theory of relativity. 772 PA R T F O U R ASTRONOMY 2. Granite (b) Sandstone Limestone (c) Marble Slate Sedimentary rocks are formed at or
near Earth's surface from the cementation or compaction of sediment—rock, mineral, shell, or solid organic fragments carried by water, wind, or ice and deposited in low-lying areas. The radiation curves show that the hotter a star is, the shorter the wavelength of its peak frequency and the bluer it looks. TUTORIAL: Nuclear Physics VIDEO:
Radioactive Decay FIGURE 13.5 The shelf life of fresh strawberries and other perishables is markedly increased when the food is subjected to gamma rays from a radioactive source. What is your answer? A carbonyl group consists of a carbon atom double-bonded to an oxygen atom. As minerals crystallize in cooling magma, which minerals are the
first to crystallize: the minerals with lower amounts of silica or the minerals with higher amounts of silica? CHECKPOINT During the span of the second time interval, the ball begins at 2 m/s and ends at 4 m/s. Each time she hits the block, she hears an echo 0.5 s later. Having a high melting point can be thought of as requiring a higher (hotter)
temperature to melt. Developed since the 1960s, this system now saves the equivalent of about 25% of freshwater consumption. 12.9 The Shell Model 25. EXPLAIN THIS F I G U R E 1 5 .1 5 I The effect of the positive nuclear charge (represented by red shading) of a fluorine atom extends beyond the atom's outermost occupied shell. 43. Three
parachutists, A, B, and C, each have reached terminal velocity at the same altitude. Rank in order of increasing average distance from the Sun: (a) Kuiper belt objects, (b) asteroids, and (c) Oort cloud objects. First try to deduce the answers based on what you know about the law of mass conservation, and then follow the steps given here to check your
 answers. The microscopic nooks and crannies on the surfaces of the grains serve as nucleation sites where carbon dioxide bubbles can (a) The carbon dioxide bubbles can (bubbles can (a) The carbon dioxide bubbles can (bubbles can (a) The carbon dioxide bubbles can (bubbles can (
Yet fiberglass is commonly used to insulate buildings. Thus, N2 is the usual elemental formula given for nitrogen. 10 Electric Power generator, electricity in your hair will be evident when each strand of hair repels other strands. One example of a water system is a garden hose that waters a garden. In the Southern Hemisphere, the surface current
moves to the east-southeast. In tearing a paper towel or plastic bag from a roll, discuss why a sharp jerk is more effective than a slow pull. Therefore in a locality in which electric energy costs 15\phi/kWh, a 1000-W clothes iron can operate for 1 h at the cost of 15\phi. \ge 8h 1h OH\ge Space-filling model of hydroxide ion Electron-dot structure of hydroxide
ion Total protons Total electrons Net charge 9 10 12 This reaction results in the formation of an ammonium ion and a hydroxide ion, which, as shown in Figure 18.4, is a water molecule without the nucleus of one of the hydrogen atoms. Instead, there's less mass in the same number of nucleons. How might these smelly molecules be conveniently
transformed into less smelly salts just before you eat the fish? Interestingly, the three colors can produce black, but that takes more ink and has a color cast—hence the black ink, which does a better job. Use this diagram for Exercises 63 and 64. Radium-226 is a common isotope on Earth, but it has a half-life of about 1620 years. Evaporite deposits
require a dry climate that causes the evaporation of lakes or seawater. If both masses are doubled? 23-Aug. A ccording to popular legend, Newton was sitting under an apple tree when the idea struck him that gravity extends beyond Earth. As the air mass moves down the other side of the mountain (the leeward slope), it warms adiabatically. Show
that the time interval between light leaving and returning to the revolving mirror was 0.0001 s. See Plate tectonics Temperature inversions, 686-689 Temperatu
radiation, 169, 664 Theories, 4 Thermal energy, 145-163 absolute zero and, 146-147 Thermodynamics, 145-163 first law of, 149-150 Thermonuclear fusion, 341 Thermodynamics, 145-163 first law of, 149-150 Thermodynamics, 150 Thunderstorms, 699 forecasting of, 701-
703 Tides, 658-659 Timbre, 255 Time/space structure. Even after they are frozen, the water molecules continue to evaporate into the vacuum, until little crystals of coffee solids remain. For example, paleontology is the study of life in ancient
geologic time. Do you know why this is so? Purifying the Water We Drink EXPLAIN THIS LEARNING OBJECTIVE Identify the industrial means by which water is purified. The greater the friction, the slower the flow. (CM: center of mass; CG: center of gravity) 726 PA R T F O U R ASTRONOMY FIGURE 26.30 A solar eclipse occurs when the Moon
 much they resist being set in motion. FYI in your body and the electrons in the wall. So the ship floats lower in the water when loaded with Styrofoam than when empty. When thermal energy is added, the increased molecular motion breaks down the frozen structure and it becomes the liquid phase, water. As cool air sinks, the expansion of warm air
 beneath it is inhibited, so we see single cumulus clouds with a great deal of blue sky between them. When they move still faster, electrons can be torn loose from the atoms, forming a plasma. A black hole, though infinitely dense, is an object found in our universe. These can clog water heaters and boilers. When a current passes through the loop, it
flows in opposite directions in the upper and lower sides of the loop. This "clean" type of breakage occurs parallel to a mineral's planes of weakness—planes along which chemical bonds are weak or few in number. What would be the consequence to Earth's climate if the greenhouse effect were completely eliminated? Hydrogen is oxidized on contact
 with hydroxide ions at the hydrogen-facing electrode (the anode). On the road, we see it operate when a car drives over buried coils of wire to activate a nearby traffic light. The asthenosphere is especially plastic, and it flows more easily than the
 water. 438 PARTTWOCHEMISTRYFIGURE17.11 Nitrogen monoxide Ea Energy, Ea, before they can transform to product molecules must gain a minimum amount of energy, called the activation energy, Ea, before they can transform to product molecules. It is possible to have more than two electrons shared between two atoms, and Figure 15.21 shows three examples.
 Silicate minerals are subdivided into ferromagnesian silicates and nonferromagnesian silicates. d = 12 gt 2 Up-and-down motion is shown in Figure 1.24. Part of Earth's magnetic field is enclosed in the wide loop of wire embedded in the road surface. On the eve of his discovery, Maxwell had a date with the young woman he was later to marry. Violet
the crumpled one falls faster? The other was that moving objects must necessarily have forces exerted on them moving. Thus when two small nuclei fuse, say two hydrogen isotopes, U the mass of the resulting helium-4 nucleus is less than the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the resulting helium-4 nucleus is less than the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the resulting helium-4 nucleus is less than the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the resulting helium-4 nucleus is less than the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the resulting helium-4 nucleus is less than the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, say two hydrogen isotopes, U the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the mass of the two small nuclei fuse, and the mass of the two small nuclei fuse, and the mass of the mass of the mass of the mass 
remain to perpetuate global warming. Mercury and Venus are never seen at night straight up toward the top of the sky. We can think of any other mass as interacting with the field and not directly with the mass that produces it. Hewitt 356: Paul G. 26.5 Earth's Moon 20. When the air is full of particles larger than oxygen and nitrogen molecules, light
of lower frequencies is also scattered, which adds to the high-frequency scattered light to give us a whitish sky. Astrological beliefs are built on anecdotal evidence that is neither reproducible nor testable. Ionic bond A chemical bond in which there is an electric force of attraction between two oppositely charged ions. The scientists realized atomic
oxygen's usefulness for restoring paintings damaged by smoke or other organic contaminants. It has a diameter four times that of Earth and a density slightly greater than that of water. Clarke Interestingly, the north pole is in Antarctica. This
is illustrated by the connecting vases shown in Figure 5.4. If the pressure at the bottom of a large vase were greater than the pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a large vase were greater than the pressure at the bottom of a large vase were greater than the pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a large vase were greater than the pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase, the greater pressure at the bottom of a neighboring narrower vase.
sandwiches when both are removed from a picnic cooler on a hot day? If you launch a projectile at any speed greater than that, it leaves Earth, traveling slower, never stopping due to Earth's gravity.* We can understand the magnitude of this speed from an energy point of view. n general, the stronger an acid, the more readily it donates
hydrogen ions. Jupiter spins rapidly about its axis in about 10 hours, a speed that flattens it so that its equatorial diameter is about 6% greater than its polar CHAP TER 26 diameter. A solar eclipse occurs when the Moon's shadow falls on Earth. No, because the force is slightly greater on the domain pole closest to the magnet than it is on the farther
pole. It senses distance by the time delay between sending sound and receiving the echo, and it senses direction by differences in time for the echo to reach the dolphin's two ears. A calorie is the modern unit of energy, where 1 cal = 4.19 J. What is a
starburst galaxy? The object to be electroplated is connected to a negative battery terminal and then submerged in a solution containing ions of the metal to be used as the coating. You tell him that the cinnamon molecules are passing through the micropores of the balloon. Which has a higher specific heat capacity: water or sand? In summary
FIGURE 8.4 When a rubber rod is rubbed with fur, electrons transfer from the fur to the rod. Tie a rope to a wall and shake the free end up and down. Elements heavier than uranium in the periodic table do not exist in any appreciable amounts in nature because they have short half-lives. (d) It depends whether the unsaturation is due to a double or not exist in any appreciable amounts in nature because they have short half-lives.
triple bond. Can you see that they do equal amounts of work? In fact, S TA R S A N D G A L A X I E S 741 86 ly 69 ly 93 ly 53 ly 360 ly 62 ly 116 ly F I G U R E 2 7. What is the weight of the scaffold? The longer the subduction zone, the more weight there is to pull on the rest of the downgoing plate. 3 4 INTERACTIVE FIGURE The white golf ball
appears white when it is illuminated with red, green, and blue lights of equal intensities. What is the ultimate source of energies for fossil fuels, dams, and windmills? The ability of one mineral to scratch another and the resistance of a mineral to being scratched are measures of hardness. Discuss why sound travels faster in moist air. What is the
shape of a magnetic field about a currentcarrying wire? (d) amplitude. On the curve, more water vapor. Compared with some original speed, how much work must the brakes of a car supply to stop a car that is moving four times as fast? The length of the arrow tells you the magnitude of the vector quantity, and the arrowhead tells you the direction of
the vector quantity. When an ice cube in a glass of water melts, does the water level in the glass rise, fall, or remain unchanged? How about that! 2. So to put a payload infinitely far from Earth's surface requires at least 62 million joules of energy per kilogram of load. LEARNING OBJECTIVE Distinguish between heat and temperature. No, impulse is
not something an object has, like momentum. A dip in 100°C water would be extremely uncomfortable for your hands! 2. Newton's second law of motion is: Here's directly proportional. (a) Identify all the forces acting on the apple and their reaction forces. The inset shows a close-up color view taken by the Hubble Telescope. Rain washed the
atmosphere of carbon dioxide, which dissolved in the newly formed oceans. Although the compound sodium chloride is composed of sodium and chlorine, the physical and chemical properties of sodium metal or chlorine gas. O R G A N I C CO M P O U N D S 495
FIGURE 19.8 (a) The double bonds of benzene, C6H6, can migrate around the ring. In the centralized model for generating electricity, a relatively small number of power plants produce the massive amounts of electricity, a relatively small number of power plants produce the massive amounts of electricity that everyone needs. What
information, and why? These lines serve as the productive life force of industry, transportation, and the electrification of civilization. But that doesn't stop cosmologists from developing models proposing possible answers. From the point of view of the molecules in the cards, it makes no difference whether the deck is shuffled. Early astronomers such
as Kepler and Newton developed the laws of gravity based on the motion of the planets around the Sun. (You'll find more on vectors in the next chapter, in Appendix B, and in the Conceptual Physical Science Practice Book.) Applied forces Net force 5N 5N 5N F I G U R E 1 .1 0 Net force. Today we know the Milky Way to be a vast collection of
more than 100 billion stars. The Earth- Moon distance is 3.84 * 108 m, so the round-trip distance is 7.68 * 108 m. Then, in 1886, two men working independently, Charles Hall (1863–1914) in France, almost simultaneously discovered a process whereby aluminum could be produced from aluminum
oxide, Al2O3, a main component of bauxite. Which has the higher frequency: red light or blue light? 1.10 Acceleration 26. Both of these detergents are biodegradable, which means that microorganisms can break down the molecules once they are released into the environment. (a) The activation energy of both these reactions must be very low. A
tuning fork can be made to vibrate even when the frequencies are not matched, although at significantly reduced amplitudes. During the perihelion, the gravitational attraction between the Sun and Mercury is strongest because that is when the distance between the Sun and Mercury is the smallest. The more you know about one, the less you can
know about the other. (a) Atoms are the smallest particles of matter that exist. 7.8 Melting and Freezing 26. et us take a closer look at the atom brick is determined by the weight of the entire stack. Only then did he publish what is one of the most far-reaching
generalizations of the human mind: the law of universal gravitation.* Everything pulls on everything else in a beautifully simple way that involves only mass and distance. The carbonates are the most abundant nonsilicate minerals. (b) The oxygen atoms of the human mind: the law of universal gravitation.* Everything pulls on everything else in a beautifully simple way that involves only mass and distance. The carbonates are the most abundant nonsilicate minerals.
molecule, making the oxygen slightly negative and the two hydrogens slightly positive. The magnitude of lift (and drag) can be altered by changing the speed of the airplane or by changing the airpl
incident ones. (d) 1 mole. We often think of current flowing through a circuit, but don't say this around somebody who is picky about grammar, for the expression "current flows" is redundant. The troughs of the waves are partially shielded from the wind, so air travels faster over the crests. If it were raised twice as high, how much potential energy
would it have? Some of the molecules in Earth's atmosphere do go off into outer space—those like helium with speeds greater than the escape speed. But the entire rubber band doesn't fall to pieces, does it? CHAPTER 7 H E AT T R A N S F E R A N D CH A N G E O F P H A S E 175 Condensation The opposite of evaporation is condensation—the
changing of a gas to a liquid. When you compare the composition of the crust to that of Earth as a whole, you see that the same few elements appear in both. If they were main-sequence stars, the giants would be dim. Consider a solid 1-ton block of iron. Because all objects emit energy to their surroundings, why don't the temperatures of all objects
continuously decrease? A thin stream of water is pulled to a rubber balloon with a static electric charge. C H A P T E R 11 Longest path of sunlight through atmosphere is at sunset (or sunrise) LIGHT 281 F I G U R E 11. Most circuits are wired so that it is possible to operate several electrical devices at once, each independently of the other. Warm air
that spreads throughout a room when the oven door is open cannot spontaneously return to the oven. Shelled marine organisms would die, which could affect the multiple paths provide less resistance (just as more lines at a checkout counter lessen resistance to flow).
(a) Two force pairs act: Earth's pull on the apple (action) and the apple's pull on Earth (reaction). (d) concept opposite to force. There is also a spot on your retina where the nerves carrying all the information exit the eye on their way to the brain. The direction of the force on a positive charge is the same direction as the field. Interestingly, this is the
same speed that water or anything else would have if freely falling the same distance h. Earth's oceans support the carbon dioxide cycle, which acts as a thermostat to keep global temperatures from reaching harsh extremes. One could escape Earth at any sustained speed more than zero, given enough time. The seven stars in the tail and back of
Ursa Major form the Big Dipper. More details about these and other future solar eclipses can be found on NASA's eclipse Web site, eclipse eclipse. html. Settling basin Insoluble-waste screen MIX TURES Sludge To tertiary treatment or outfall Sludge recycled To solid-waste disposal site or
incinerator FIGURE 16.38 A schematic for secondary-level treatment of wastewater from a municipal system. (b) If 325 kg of olivine and 225 kg of olivine and 225 kg of olivine and 225 kg of pyroxene have crystallized out of the 1000 kg of magma, what is the mass percentage of silica in the remaining liquid? Your weight is mg when you are firmly supported and in equilibrium. Usually the
effects of a mutation are insignificant, TA B L E 1 3. We will now turn our attention of sediments lead to (a) magma generation. The gravitational influence of every material object, however small or however far, is exerted through all of space. The other 15 weather elements are in
standard position around the circle. Pour some dry sand into a tin can that has a cover. Each molecule of exhaust gas is like a tiny cannonball shot from the beryllium atom. How does the charge of an electron differ from the charge of a proton? A
star's color directly tells you about its surface temperature—for example, a blue star is hotter than a yellow star is hotter than a red star. CHECKPOINT What are two common fates for light shining on a material that isn't absorbed? Because acid-base is seen as a behavior, there is really no contradiction when a chemical like water
behaves as a base in one instance but as an acid in another instance. Our fuel-exhausted Sun will continue to shrink until the electrons within the Sun are so squeezed that they resist any further compression. The total voltage impressed across a series circuit divides among the individual electrical devices in the circuit so that the sum of the "voltage
drops" across the resistance of each individual device is equal to the total voltage supplied by the source. If the density of air inside the pole matches the density of air outside, the enclosed mass of air would be about 1 kg. It doesn't matter which force we call action and which we call reaction. (d) volume. (c) ultra high-frequency sound. Partial
melting of oceanic crust also occurs. Minerals that are easily dissolved (high solubility) remain in solution longer—they are the last to crystallize. In the winter of 1811-1812, a series of strong earthquakes along this zone permanently changed the course of the Mississippi River! With an estimated magnitude of 8.0 on the Richter scale, the
earthquakes were so strong they caused church bells to ring in Boston, Massachusetts, 1600 km (1000 mi) away! Fortunately, because the region was sparsely settled at the time, the loss of human life and property was minimal. Use Ohm's law to express V and show that power can be expressed by the equation P = I 2R. Your weight would decrease in
Earth expanded with no change in its mass and would increase if Earth contracted with no change in its mass. In any case, a white dwarf cools for eons in space until it becomes too cold to radiate visible light (Figure 27.14). Tar residues within the salicylic acid had a nasty taste. 3 Ca(OH)2 Al2(SO4)3 Slaked lime S
it would have been sent 4.4 years ago. As it loses its tungsten, the filament eventually breaks and the bulb "burns out." A remedy is to replace the air inside the bulb with a halogen gas, such as iodine or bromine. A lone neutron is radioactive, and spontaneously transforms to a proton and an electron (Figure 13.14a). Perchloroethylene, also known as
 perc, is relatively safe, but it is mildly carcinogenic and can cause dizziness in those who work with it. Cumulus clouds often remain in the same place that they formed, dissipating and reforming many times. Anyone who has ridden in a convertible car with the canvas top up has noticed that the roof puffs upward as the car moves. How many multiple
bonds must a hydrocarbon have in order to be classified as unsaturated? Some aromatic compounds, such as naphthalene, contain two or more benzene rings fused together. Just as sheet music guides a musician playing music, equations guide a physical science student to understand how concepts are connected. Magenta + green = white ( = red +
blue + green) Cyan + red = white ( = blue + green + red) Yellow + blue = white ( = red + green + blue) F I G U R E 11. CHECKPOINT F I G U R E 16.19 Why isn't sucrose infinitely soluble in water? Energy must be transmitted some other way—by radiation.* The transferred energy is called radiant energy. 4.2 Gravity and Distance: The Inverse-
Square Law EXPLAIN THIS LEARNING OBJECTIVE Describe the rule by which gravity diminishes with distance. To avoid awkwardly large numbers, scientists use a unit called the mole. When the path of either of these bodies crosses into the shadow cast by the other, an eclipse occurs. The dark lanes and blotches are interstellar gas and dust
obscuring the light from the galactic center. In the drier cities, the rate of evaporation from your skin is much greater than the rate of condensation of water molecules from the air onto your skin. FYI 244 PA R T O N E P H Y S I CS LOUDSPEAKERS The loudspeakers of your radio and other sound-producing systems change electrical signals into
sound waves. What is a polymorph? No net force means no change in motion. Does hang time depend on your vertical component of velocity, or both? Some chemicals, such as calcium carbonate, CaCO3, actually become less soluble as the water temperature increases. What is the mass of a
 water molecule in atomic mass units? The wind bounces from the sail and produces a greater impulse than if it merely stopped. A N N UA L R A D I AT I O N E X P O S U R E Source Natural Origin Cosmic radiation Ground Air (radon-222) Human tissues (K-40; Ra-226) Human Origin Medical procedures Diagnostic X-rays Nuclear medicine TV tubes
other consumer products Weapons-test fallout Typical Dose (mrem) Received Annually 26 33 198 35 FIGURE 13.8 40 15 11 1 The film badges worn by Tammy and Larry contain audible alerts for both radiation surge and accumulated exposure. P Mirror Grass 76. VIDEO: Electric Potential VIDEO: Van deGraff Generator LEARNING OBJECTIVE and accumulated exposure.
Recognize how a potential difference is necessary for electric current. After they achieve success with simple forces, the coverage touches lightly on kinematics, enough preparation for Newton's laws of motion. Why do the leaves of a red rose become warmer than the petals when illuminated with red light? Consider a neon-sign transformer that
operates off 120-V lines. What are its (a) frequency, (b) period, and (c) amplitude? A physics instructor demonstrates energy conservation by releasing a heavy pendulum bob, as shown in the sketch, allowing it to swing to and fro. (e) D, C, B, A. As she falls faster and faster through the air, does her acceleration increase, decrease, or remain the same
However, there is a slight time delay between absorption and re-emission. Such knowledge will be particularly applicable to medicine. The result is upward bending (Figure 11.24). CHAPTER 5 5.9 Bernoulli's Principle EXPLAIN THIS Why does a spinning baseball curve when thrown? FIGURE 20.9 Were these your answers? The average speed of this
commuter's round-trip is 20 kilometers divided by the total commute time—a value greater than zero. 698 PARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREE
universe. CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E 785 Many other intriguing models attempt to explain the nature of dark energy. (a) Show that the average speed of a tennis ball is 48 m/s when it travels the full length of the court, 24 m, in 0.5 s. The 16th-century Polish astronomer Nicolaus Copernicus caused great
controversy when he published a book proposing that the Sun is stationary and that Earth revolves around the Sun. The height is t/2. (d) all of these 3. On this scale the number 32 is assigned to the temperature at which water freezes, and the
number 212 is assigned to the temperature at which water boils. At the core-mantle boundary, a very pronounced wave shadow develops. What would happen to the baking soda solution if you were to slowly add vinegar to it? A practical application is a message or tape recorder. The forces are different because the masses are different, in accord
with Newton's second law. You could not cook food in low-temperature water that is boiling by virtue of reduced pressure. While you are hiking in the wilderness, you find a shiny, glassy-looking mineral. In one scenario, called heat death, the universe will continue to expand, approaching absolute zero and a state of maximum entropy. To understand
why objects reflect specific colors of light, we turn our attention to the air mass? Assume it has only enough friction to roll, but
not to lessen its speed. When such organisms die, their shells accumulate on the sea floor. The stars and planets are said to affect such personal things as one's character, marriage, friendships, wealth, and death. They literally pick up everything in their path. CHAP TER 25 37. CHECKPOINT What is the chemical formula for the ionic compound
of a fuel to electric energy. Albrecht, ESA/ESO Space Telescope European Coordinating Facility; NASA 731: (a) NASA/Science Photo Library/Photo Researchers, Inc. Recrystallization occurs because the rock is exposed to high temperatures or pressures. Initially, we see two
hydrogen atoms before the reaction arrow and three on the right. These are the rock-forming minerals. Show that the power consumed by the appliance is 720 W. Furthermore, these reactors can be built as small modular units that generate between 150 and 600 megawatts that is the usual output of today's
reactors. Most of these techniques employ the simple principle of separating the components by differences in their physical properties. Opening a refrigerator door lets warm air in, which then takes energy to
cool. The only difference is the relative orientation of the H2O molecules to one another. Mars is a little more than half Earth's size; its mass is about one-ninth that of Earth; and it has a core, a mantle, a crust, and a thin, nearly cloudless atmosphere. A harp produces softer sounds because its sounding board is smaller and lighter. Taking heat energy
into account, we find that energy transforms without net loss or net gain. The uppermost portion of the glacier, carried along both by basal sliding and by internal plastic deformation, behaves like a rigid, brittle mass that may fracture. Look at some crystals of table salt under a microscope or a magnifying glass and observe their generally cubic
shapes. 10.10 Musical Sounds EXPLAIN THIS How do musical instruments produce their characteristic sounds? (b) For 10 h? Then the ground simultaneously pushes upward on you with the same amount of force. What is the net magnetic force on a compass needle? When switched on, the very thin tungsten filament heats up to 3000°C and roughly
doubles its resistance. CHAPTER 9 M AG N E T I S M A N D E L E C T R O M AG N E T I C I N D U C T I O N 225 MRI: MAGNETIC RESONANCE IMAGING Magnetic resonance imaging scanners provide high-resolution pictures of the tissues inside a body. How much more force can the larger piston exert compared with the force applied to the
smaller piston? (c) Actually both will increase at the same rate. Assuming that the heating inside the battery is negligible, what happens to the brightness of each bulb when more and more bulbs are connected in parallel? 3 8 (f) Only three colors of ink (plus black) are used to print color photographs—(a) magenta, (b) yellow, and (c) cyan, which when
combined produce the colors shown in (d). It is important to understand this, for it is the crux of satellite motion. The definition is fairly straightforward. If the elongation passes a certain point, the electric forces overwhelm the strong nuclear forces, and the nucleus splits. What metal coats a galvanized nail? No, a force is not something an object has,
like mass; it is part of an interaction between one object and another. Is carbon dating advisable for measuring the age of materials a few years old? Water Vacuum Insulator To vacuum pump F I G U R E 7. You're moving relative to the Sun and stars—though you are at rest relative to Earth. Threefourths of the first bottle are poured out for drinking,
 while only one-fourth of the second bottle is poured. FYI No. A liquid cools only when more energetic molecules escape. A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 24. 73. With no component of force along its direction of motion, its speed remains constant. The general chemical equation for photosynthesis is shown below. (c) color
interference. In this case, the fired ball hits first. One of the first clues came to us as we were mapping the speeds at which stars orbit our galactic center. Some thinking shows that ©T1 is the final temperature T minus 25°C, because T will be greater than 25°C. No, each hand pushes equally on the other in accord with Newton's third law. Put a cup
of water in a Pyrex saucepan and heat it slowly over a low flame. 719: (bottom has 720: (bottom right) NASA 720: (bottom right) NASA, ESA, L. 268 PARTONEPHYSICSFIGURE 11. A magnetic force is similar to an electrical
force in that a magnet can both attract and repel without touching (depending on which end of the magnet is held near another) and the strength of its interaction depends on the distance between magnets. Every atom has a positively charged nucleus surrounded by negatively charged electrons. Pieces of mechanically weathered rock are normally
quite angular and jagged when they are first produced. 6 Heat Transfer and Change of Phase 7. What if you did this in a mineshaft below sea level? Aluminum ions carry a 3+ charge, and chloride ions carry a 1- charge. Each year, the damage costs billions of dollars. We represent the force vector as acting midway along the lower wing surface, where
the dot is, and pointing above the wing to show the direction of the resulting wind impact force. When the crest of one wave overlaps the trough of another, their individual effects are reduced. Is the solution acidic or basic? Consider one of the simplest machines, the lever (Figure 3.28). Cleavage planes are determined by crystal structure and
chemical bond strength. VIDEO: Definition of Speed VIDEO: Average Speed VIDEO: Velocity VIDEO: Changing Velocity VIDEO: C
The safety systems of these reactors are "active" in that they rely on active Power lines Boiling water Steam Transformer Reactor Control rods FIGURE 13.26 Diagram of a nuclear fission power plant. An ammeter is connected next to each battery as shown. Manufacturing Buyer: Jeffrey Sargent Manager, Rights and Permissions: Zina Arabia
Manager, Cover Visual Research & Permissions: Karen Sanatar Image 
assemblage of stars, interstellar gas, and dust. Which of these elements might you therefore expect to have the smaller critical mass? The first coil is connected to a battery and has a direct current flowing through it. A friend says that initial forces from long ago keep them moving. Studies show that students who use MasteringPhysics significantly
increase their scores compared to doing handwritten homework. Geothermal energy is held in underground reservoirs of hot water. Space probes have yet to visit any of the dwarf planets of the Kuiper belt. Which are closer together: the two nuclei within potassium fluoride, KF, or the two nuclei within molecular fluorine, F2? Equal masses of
different materials require different guantities of heat to change their temperatures by a specified number of degrees.* As mentioned earlier, a gram of water requires 1 calorie of energy to raise the temperature 1°C. The hydrosphere is where life on Earth began, and the atmosphere provides the oxygen animals need and the carbon dioxide plants
need. Hewitt 253: U.S. Navy News Photo 254: Ted Kinsman/Photo Researchers, Inc. Although we certainly know much more than we used to know, much still remains unknown. The tight lid of a pressure cooker holds pressurized vapor above the water surface, and this inhibits boiling. [Hint: Equate the joules of gravitational potential energy to the
product of the mass of ice and its heat of fusion (Lf = 335,000 J/kg).] (b) Explain why the answer doesn't depend on mass? So a moving charge is deflected when it crosses through a magnetic field, but when it travels parallel to the field, no deflection occurs. What are the three common ways in which heat is transferred? 730 PARTFOUR
ASTRONOMY FIG URE 26. The metal emerges in a molten state that can be cast into a variety of useful shapes. A positive ion has a net positive ion has a net positive ion has a net positive in close proximity, thermal energy transfers in a direction from the warmer object to the cooler object.
Looking Back in Time 28. FIGURE 6.3 Particles in matter move in different ways. Because winds set surface waters in motion, atmospheric circulation and oceanic circulation and oceanic circulation are interrelated. How does the density of air in a deep mine compare with the density of air at Earth's surface? Activation energy The minimum energy required in order for a
chemical reaction to proceed. When the same particles move so fast that they disconnect and fly loose, we have a gas. After a washing cycle, the solvent is centrifuged out of the machine, filtered, distilled, and recycled for the next load. It has undergone very little change since then. Momentum = mv = (2 kg) (8 m/s) = 16 kg # m/s. Sound travels
faster through warm air than through cold air. Distinguish between constructive interference and destructive interference. However, knowing the vertical drop is 5 m, you remember that a 5-m drop takes 1 s! From the equation for constant speed (which applies to horizontal motion), v = d/t = (20 m)/(1 s) = 20 m/s. Water and soap are attracted to
each other primarily by strong ion-dipole attractions between the polymer is hard and rigid, but above which the polymer is soft and flexible. No fusion-based nuclear
power plants are in operation today. Looking at Table 20.1, we see that fluorite is harder than calcite. Over the noise of the jackhammer, the operator can easily hear your voice, while you are unable to hear his. If you shake with a frequency twice as great, how many wave segments occur in your new standing wave? The change of phase is from gas
to liquid, which releases energy (Figure 7.34). It is experimentally established that the two are equal, and, as a matter of principle, the equivalence of inertial and gravitational mass is the foundation of Einstein's general theory of relativity. The Voyager 2 spacecraft flew by Neptune in 1989. What is meant by an ideal machine? The added slaked lime
and aluminum sulfate capture these suspended solids, which then sink to the bottom, where they are easily removed. Starting at 0°C, the pressure for each Celsius degree its temperature was lowered. A force sustained for a long time produces more change in
momentum than does the same force applied briefly. For higher altitudes, the orbital speed is less, the distance is more, and the period is longer. THINKANDSOLVE (MATHEMATICALAPPLICATION) 37. READINGCHECK QUESTIONS (COMPREHENSION) 12.1 Atoms Are Ancient and Empty 1. THINKANDSOLV
E (MATHEMATICALAPPLICATION) The quantity of heat Q released or absorbed from a substance of specific heat capacity c (which can be expressed in units cal/g # °C) and mass m (in g or kg), undergoing a change in temperature ©T is Q = cm©T. For example, if the pressure of city water is increased at the pumping
station by 10 units of pressure, the pressure everywhere in the pipes of the connected system is increased by 10 units of pressure (providing the water molecule and a water molecule. Because we are now more aware of the environmental
costs of fossil-fuel combustion, biomass fuels are making a slow comeback. With no stirring, which would you expect to become uniform in color first: the hot water or the cold water? TUTORIAL: Rain Shadow is a place where
little rain falls because some obstacle (such as a mountain) blocks precipitation. The more loops in the coil, the stronger the electromagnet that you produce and the stronger it pushes back against you. Even when idling, a typical automobile engine emits more than 100 billion particles per second. For water, this is 334 J/g. His wife Tracy is shown
with son Ian on page 296 and with son Evan on page 355. The event horizon is simply the boundary of no return. Therefore her density is 90% of the water's density. So in addition to the abundant energy produced, fission fuel is bred from the relatively abundant U-238 in the process. Just as buildings are made of different materials—some stone,
some brick, some wood—minerals are made of different elements. Distant galaxies are thus seen to be accelerating from each other. The equilibrium level marks the upper limit of cloud formation. This happens in the case of low-temperature metamorphism. (a) With a bit of algebraic reasoning show that your gravitational acceleration toward any
planet of mass M a distance d from its center is a = GM/d 2. dioxide molecule, and so the molFigure 15.26 illustrates a similar situation for boron trifluoride, BF3, in ecule is nonpolar. So, in a molten or nearly molten state and under the influence of gravity, dense, heavy iron-rich material sank to Earth's center and less-dense, siliconand oxygen-rich
material rose toward the surface (see Chapter 5). The tension is 20 N. Alpha radiation decreases the atomic number of the emitting element by 2 and the atomic number by 4. C H A P T E R 15 395 9. (a) +899 kJ/mol (b) -993 kJ/mol (c) +80 kJ/mol (d) -80 kJ/mol (d)
sleeping out at night on granite outcroppings. The most drastic way this could happen is shown in Figure C.4 (a), where the rate of consumption, such as barrels of oil per year, is plotted against time, say in years. o far you have learned that the atoms of a molecule are held together by covalent bonds. (a) There is a greater number of effective
collisions among reacting molecules. 5 Two moles of H2 react with 1 mole of O2 to give 2 moles of H2O. But there are common features in the way scientists do their work. 488 PARTWOCHEMISTRY READINESS ASSURANCETES TO MISSEN CONTROLLER STORY READINESS ASSURANCE TO MISSEN CONTROLLER STORY READINESS ASSURA
7 out of 10 on this RAT. 91. Finding Components of Vectors TUTORIAL: Vectors F FIGURE B.4 ecall from Chapter 2 that to find a pair of perpendicular components). (Polarization does not occur among longitudinal waves—there is
no such thing as polarized sound.) A single vibrating electron can emit an electromagnetic wave that is planepolarized. A rain shadow occurs on the leeward side. Which set is analogous to a sample of once-living ancient material? How many moles of water are there in 18 g of water? (b) Carbon soot collects above the flame. As the cold front continues
to invade the warm front, the warm front, the warm front itself no longer touches the ground (Figure 25.14c). Furthermore, during an electricity blackout, a family's pluq-in hybrid would store enough energy to serve as emergency backup for household needs. For free fall, the downward net force is weight—only weight. Hewitt (top) Paul G. The saturation vapor
pressure and the evaporation rate would both go down, so the relative humidity would go up. LEARNING OBJECTIVE Describe how the strong nuclear force acts to hold nucleons together in the atomic nucleus. Is it correct to say that a generator produces energy? It's clear that dark matter is not simply ordinary matter, such as expired stars, that
have gotten so cold that they emit no light. Support for this idea came from magnetic surveys of the ocean floors that O D D - N U M B E R E D S O LU T I O N S showed alternating stripes of normal and reversed polarity, paralleling either side of the spreading rift areas. These pieces of glass contain dyes or pigments—fine particles that selectively
absorb light of particular frequencies and selectively transmit others. Fault line at surface Epicenter Seismic waves Focus 2010 was a devastating year for earthquakes along strike-slip faults! Earthquakes in Haiti and New Zealand were both of similar size and a result of strike-slip faults! Earthquakes in Haiti and New Zealand were both of similar size and a result of strike-slip faults! Earthquakes in Haiti and New Zealand were both of similar size and selectively transmit others.
the density of the liquid changes? They are equal. Water vapor does not need to be high in a cloud to form precipitation— condensation can occur in air close to the ground as well. Light-year The distance light travels in one year. Electrically polarized Term applied to an atom or molecule in which the charges are aligned so that one side has a slight
excess of positive charge and the other side a slight excess of negative charge. The amount of energy in a gamma ray, however, is much greater than in visible light, ultraviolet light, or even X-rays. This is because the transfer of thermal energy by conduction, convection, and radiation is severely inhibited. This refracted light shines on an otherwise
dark Moon. Compared to Earth, however, the Moon is relatively small, with a diameter of about the distance from San Francisco to New York City. Below that is the negative of the photo, which shows these colors differently. The weight reading is the same. They occur in pairs and make up one interaction between two things. Why, then, don't these
pennies quickly corrode? We learned in Chapter 9 why this is so: The shaking stick creates an electric field—electromagnetic field induces an electric field—electromagnetic field induces an electric field induces and electric field induces an electric field induces and electric field induces and electri
upward against the gravestones but, instead, forms depressions around them, as shown. Neglecting air resistance, what happens to the vertical component of its velocity along its trajectory? 8 The hot steam expands as it leaves the pressure cooker and is cool to Millie's touch. Even if you were transported to the far reaches of the universe,
INTERACTIVE FIGURE the gravitational influence of home would still be with you. No torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field, the oppositely directed forces produce a pair of torque FIGURE 9.4 When the compass needle is not aligned with the magnetic field in the compass needle is not aligned with the magnetic field in the compass needle is not aligned with the magnetic field in the compass needle is not aligned with the magnetic field in the compass needle is not aligned with the magnetic field in the compass needle is not aligned with the magnetic field in the compass needle in the compass needle is not aligned with the magnetic field in the compass needle in the c
in the middle of the oceans and deep ocean trenches near some continental landmasses. (a) cosmic background radiation (b) homogeneity of the temperature of the universe (c) the abundance of helium (d) dark energy 2. When the combined waves reach our ears in step—say, when a compression from one fork overlaps a compression from the other—
the sound is at a maximum. CHAP TER 26 not sent up with the debris), and much more. F I G U R E 1 3 .11 INTERACTIVE FIGURE (a) Two protons near each other experience both an attractive strong nuclear force and a repulsive electric force. But by the passing of 10150 years, they too will depart as they evaporate into photons and leptons. The
air pressure is repeatedly lowered by piston and valve action (Figure 5.29). This coat is so thin that it's transparent, which is why aluminum maintains its metallic shine. So we find that mass is neither weight nor volume. (b) a temperature inversion. A battery doesn't supply electrons to a circuit; it instead supplies energy to electrons that already exist
in the circuit. Gamma rays are the high-frequency electromagnetic radiation emitted by radioactive elements. Space does not expand locally within our galaxy or between neighboring galaxies. CHAPTER 11 1. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 6.1 Temperature 1. (b) The total silica removed from the magma: 114 kg from
olivine (from Figuring Physical Science box) + 117 from pyroxene = 231 kg silica in original magma - 231 kg silica in remaining liquid is 1000 kg - 325 kg - 225 kg = 450 kg. More properly, charge flows—which is current. Electron cloud Nucleus CHECKPOINT A friend claims there
are atoms in his brain that were once in the brain of Albert Einstein. Like the weather, the atom is a complex system of interacting components, and it is best described with a conceptual model. The most obvious characteristic of slate is its excellent rock cleavage, which allows it to be split into thin slabs. Troposphere The atmospheric layer closest to
Earth's surface, 16 km high over the equator and 8 km high over the poles, containing 90% of the atmosphere's mass and essentially all of its water vapor and clouds. You can in(b) crease the rate by pouring in granulated sugar, salt, (a) FIGURE 16.22 or sand. Where water gains speed, pressure is lowered and bubbles become bigger. Once inside the
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event horizon, she could no longer communicate with the outside universe; neither light waves, radio waves, nor any matter could escape from inside the excitedly rushed naked through the streets shouting "Eureka!" ("I have found it!"). LEARNING OBJECTIVE Describe how the work
done on an object relates to its change in energy. Water in the melon has more "thermal inertia" than sandwich ingredients, and it resists changes in temperature much more. With each successive refinement, the theory grows stronger. Also, as the nebula shrank, it spun faster and faster (because of the conservation of angular momentum discussed
in Chapter 3). Lewis, who first proposed the concepts of shells and valence electrons). (b) More water molecules enter the cell than leave the cell. In this way, the seismograph records ground movement. Kinetic energy depends on speed squared. Density is a property of all matter, minerals included. 3.10 Sources of Energy 28. Put the beta
emitter in your pocket because beta particles are likely stopped by the combined thickness of your clothing and skin. Another within clusters. Without resistance to reduce its speed, the Moon or any Earth satellite "falls" around Earth indefinitely
For planet Earth, the escape speed is 11.2 km/s. With each pass of a comet about the Sun, the comet's mass (a) remains virtually unchanged. The diameter of our solar system including the Oort cloud is twice 50,000 AU, or about 100,000 AU. What are the temperatures for freezing water on the Celsius and Fahrenheit scales? The fact that speed or
velocity is squared for kinetic energy clearly distinguishes the concepts of kinetic energy and momentum. For the system in Figure 16.33a, osmotic pressure is the consequence of the salt water's greater height. The event horizons of these black holes are about as large as our solar system! Most large galaxies, including the Milky Way, have such
black holes in their centers, and these massive black holes can be a source of much activity. Do the activity suggested in Figure 10.24 with a stereo sound system. Remarkably, we already possess the technology to solve many environmental problems. Likewise, in an expanding universe, any observer sees all other galaxies moving away. Many
meteorites are embedded in ice, which indicates that they came from above. A conceptual model, by contrast, is used to represent abstract ideas or to demonstrate the behavior of a system. How does the stopping distance compare? (b) Branched hydrocarbons, such as isooctane, burn less readily and are ignited not by compression alone but only com
when the spark plug fires. b, 7. If you lean more on one scale than the other, more than half your weight will be read on that scale but less on the other, so they will still add up to your weight. 17.6 Chemical Reactions Are Driven by Entropy 24. Water, H2O, and methane, CH4, have about the same mass and differ by only one type of atom. The pH of a
solution can be approximated with a pH indicator, which is any chemical whose color changes with pH. A golfer teeing off and a baseball player trying for a home run do both of these things when they swing as hard as possible and follow through with their swings. When you stand with your back to the Sun, you see a rainbow as a circular arc. Novae
and Supernovae F I G U R E 2 7.1 4 A white dwarf, shown here in an artist's sketch, is the final stage in the evolution of low- and medium-mass stars. (The specific heat capacity of iron is 450 J/kg # °C. If a star collapses to half its radius with no mass change, gravitation at its surface increases fourfold (in accordance with the inverse-square law).
Removing the sail and turning the fan around is the best means of propelling the craft! Then maximum impulse is exerted on the craft. (b) To an inside observer, the ball bends as if in a gravitational field. Similar to heat flow, when the ends of an electric conductor are at different electric potentials—when there is a potential difference—charges in the
conductor flow from the higher potential to the lower potential. Aristotle claimed that the speed of a falling object depends on its weight. Thus power at one voltage from the primary is transferred to the secondary at a different voltage. Porosity The volume of open space in rock or sediment compared to the total volume of solids plus open space. (c) a
path directed toward Earth's surface. 10.4 Sound Waves EXPLAIN THIS T Why doesn't sound travel in a vacuum? 2 C4H10(g) + 13 O2(g) + 20 NO2(g) + 14 H2O(g) Use the following illustration to answer Exercises 49-51. It provides us with a way of connecting things, of seeing
relationships between and among them, and of making sense of the great variety of natural events around us. Each 1 water molecule is about 20 as massive as (and much smaller than) each sucrose molecule, which means that about 10 times as many water molecule is about 20 as massive as (and much smaller than) each sucrose molecule, which means that about 10 times as many water molecule is about 20 as massive as (and much smaller than) each sucrose molecule, which means that about 10 times as many water molecule is about 20 as massive as (and much smaller than) each sucrose molecule, which means that about 10 times as many water molecule is about 20 as massive as (and much smaller than) each sucrose molecule, which means that about 10 times as many water molecule is about 20 as massive as (and much smaller than) each sucrose molecule.
M I S T RY FIGURE 16.7 MATTER A chemical classification of matter. Its temperature divisions are identical to the divisions on the Celsius scale. Solubility A measure of the ease with which a mineral can be dissolved. The missing 4 million tons of mass are discharged as radiant energy. Because the time of the interaction is the same for both the ball
and the guardrail, the impulses are also equal and opposite. The energy produced by this electronic sloshing is tapped at the electrode terminals of the generator. He soon ran afoul of the Church and was warned not to teach and not to hold to Copernican views. In this state, dense elements sank toward Earth's center and lighter elements migrated
upward to the surface. Whenever we wish the force to be small, we extend the time of contact. SAM PLE PROBLEM 1 How much current flows through a lamp with a resistance of 60 \tau when the voltage across the lamp is 12 V? (b) The lower the electronegativity of an atom, the lower its ability to become oxidized. Indeed, scientists have found
evidence of the leakage of underground liquid water onto the surface occurring since we started surveying Mars from space. 544 PARTH SCIENCE LINK TO BIOLOGY Fossil Fuels When ancient plants and animals died, most of the organic matter they were made of was quickly decomposed by bacteria and converted to
nutrients consumed by other organisms. But an equal mass of iron on the same stove would rise through the same temperature range in only about 2 minutes. We must work out how much of one reactant is needed in order for all of the other reactant to be consumed. When illuminated with green light, why do the petals of a red rose appear black?
The equation for this reaction is 2 Na(s) + Cl2(g) h 2 NaCl(s) Scientists have experimented FYI with ways of enhancing the ocean's ability to absorb atmospheric carbon dioxide. E X E R C I S E S (SYNTHESIS) 71. Of these, about 90 are found in nature. Consider a space pod somewhere between Earth and the Moon, at just the right distance so that
the gravitational attractions to Earth and the Moon are equal. CHAPTER 19 1. Project red, green, and blue lights on a screen and where they all overlap, white is produced. With no gravity, the projectile would follow a straight-line path (dashed line). EXPLAIN THIS LEARNING OBJECTIVE Differentiate ionic, polar covalent, and nonpolar covalent
chemical bonds. In both cases, the increased PE is the result of work input. 78. In describing solutions, the component present in the largest amount is the solvent, and any other components are solutes. What is the relationship between a supernova and a neutron star? But a radio wave is definitely not a sound wave, which we learned in the previous
chapter is a mechanical vibration of matter. For an expanding rubber band, we see that a dot twice as far away travels twice as far away travels twice as fast. The positive sodium hypochlorite combines with the negative chloride ion of hydrochloric acid. Nor did he know that our galaxy is just one of billions and billions. It is interesting to compare the field
patterns in Figures 9.3 and 9.5 with the electric field patterns in Figures 8.10 and 8.11 in the previous chapter. 3 Physical and Chemical Proper ties 14. The exceptions are mercury, Hg; gallium, Ga; cesium, Cs; and francium, Fr, which are all liquids at a warm room temperature of 30 CH E M I S T RY FIGURE 18.36
(a) Neither atom in an oxygen molecule can preferentially attract the bonding electrons. (Add more baking soda if you don't.) If your silver piece is very tarnished, you may notice the unpleasant odor of hydrogen sulfide as it is released back into the air. For example, if the wavelength is 10 m and the time between crests at a point on the surface is 0.5
s, the wave is traveling 10 m in 0.5 s and its speed is 10 m divided by 0.5 s, or 20 m/s. Explain, using concepts from this chapter. Cirque, tarn, arête, horn, moraines (lateral, medial, and terminal), hanging valleys, and a characteristic U-shape valley. Does a 2-kg iron block have twice as much inertia as a 1-kg bunch of bananas? If a 25-kg object
displaces 20 kg of fluid upon immersion, its apparent weight equals the weight of 5 kg. In an elliptical orbit there is a component of force in the direction of motion. C. In fact, before the advent of rockets, it was commonly thought that sending a rocket to the Moon was impossible. If you fire a bullet through a board, it will slow down inside and
emerge at a speed that is less than the speed at which it entered. This can be tricky because in both cases changes in physical appearance occur. This periodic variation in the loudness of sound is called beats, and it is due to interference. A railroad locomotive is at rest with its whistle shrieking, and then it starts moving toward you. How does this
relate to each mineral's crystal structure? Locating black holes is very difficult. When a collapsing star contracts within its own event horizon, the star still has substantial size. With less mass, the Sun would have less of a warping effect on spacetime. 20°C 25°C F I G U R E 6.1 2 Because water has a high specific heat capacity and is transparent, it
takes more energy to warm the water than to warm the land. Inside them, the pressure exceeds 3 million times Earth's atmospheric pressure. D I S C U S S I O N Q U E S T I O N S (SYNTHESIS) 92. The yellow portion on the left side of each diagram represents the undisturbed area. What is the angle between a light ray and its wavefront? Earth's
gravitational pull continuously slows it down but never reduces its speed to zero. As light waves travel through expanding space, the light waves themselves stretch out. Distinguish between forced vibrations and resonance. For example, water is a liquid, while the elements that are in it, hydrogen and oxygen, are gases. Furthermore, the metal ions
are not rigidly held to fixed positions, as ions are in an ionic crystal. Alkaline mixtures found many uses, particularly in the preparation of soaps (Figure 12.14). Eventually granitic magma (70% silica) is produced, and when this cools, granitic-type rocks form. Cold air moving down a mountain slope is compressed as it moves to lower elevations
FIGURE 25.5 g * As we learned in Chapter 7, evaporation removes heat from the surrounding environment. What commonly supplies the energy input to a turbine? Another way to think about this concept F I G U R E 2 1. Consider a pair of flashlight bulbs connected to a battery. So the electrons of the lithium atom are not drawn in as close to the
nucleus. If the bullet were larger and disturbed more air in its path, the crack would be more boomlike. They are also ductile, which means they can be drawn into wires. They would if all uranium atoms fissioned so easily. Future space travelers, however, need not be subjected to weightlessness. Given that the speed of sound is 340 m/s, how far does
the sound travel between wing beats? The dry climate means that cloud bases are usually high in the sky—hence the sky looks "bigger." FYI High clouds are clouds that form at altitudes above 6000 m. The composition of Earth's mantle. Why does the light dispersed by the raindrops form a bow? If sound becomes
louder, which wave characteristic is likely increasing: frequency, wavelength, amplitude, or speed? Ba . Hewitt 290: (right) Shutterstock 291: Paul G. Stand facing a wall with feet flat on the floor and arms extended upward. It is one of nature's many symmetries. Why does putting a lid over a pot of water on a stove shorten the time needed for the
water to come to a boil, whereas, after the water boils, the use of the lid only slightly shortens the cooking time? Molar mass The mass of 1 mole of a substance. Saturation vapor pressure is the upper limit of humidity. Reduction The process whereby a reactant gains one or more electrons. Do a pair of parallel current-carrying wires exert forces on
each other? Prospectors look for sedimentary rock. When you throw a ball, you do work on it to give it speed as it leaves your hand. All parts of a forming planet pull close together by mutual gravitation. Therefore on average, each nucleon contributes a mass of 1 amu. The mid-latitude location of Chile and the gentle dip of the fault (thrust fault*)
shifted Earth's overall mass distribution. 336 PARTTWOCHEMISTRY With the rise of the German Nazis in the 1930s, many scientists, especially those of Jewish ancestry, fled mainland Europe to America. To vacuum pump What do the experiments of Figures 5.20 and 5.21 demonstrate? The particles in the solid vibrate around fixed positions
while those in a liquid tumble loosely around one another. These symbols are called weather codes. Is the sliding puck in equilibrium? What is the hang time if the player reaches the physical changes involved in the making of
sugar on snow. Through this reaction are the oxygens of the water molecules, H2O, oxidized or reduced? The environmental aspects of chemistry are also highlighted—from how our drinking water is purified to how atmospheric carbon dioxide influences the pH of rainwater and our oceans. Agree; at thermal equilibrium the gases have the same
temperature, which is to say, the same average KE. To obtain the amount of solute, you should multiply solution concentration by amount of solution: (2 moles/L)(0.5 L) = 1 mole which is the same as 6.02 * 1023 molecules. CHECKPOINT In what sense is drifting in space far away from all celestial bodies like stepping off the top of a stepladder? Mass
and weight are directly proportional to each other.* If the mass of an object is doubled, its weight is also doubled, its weight are directly proportionally. In answering this question, bear in mind that human growth is an early phase of life that continues
normally through adolescence. She may even find anecdotal evidence to support her contentions. Do you suppose a magnetic field is associated with these particles? Planets The major bodies orbiting the Sun that are massive enough for their gravity to make them spherical and small enough to avoid having nuclear fusion in their cores. If the wall is
m behind the opening (2 m from the light source), the illuminated area covers 4 m2. Distant dark mountains are bluish in color. Smaller cubic sodium fluoride and aluminum oxide, are a consequence of how the ions pack together. VIDEO: Air Has Weight
VIDEO: Air Is Matter VIDEO: Air Is Matter VIDEO: Air Has Pressure Interestingly, von Guericke's demonstration preceded knowledge of Newton's third law. Might this bottle water actually contain extra quantities of oxygen, O2? Many dry cereals are fortified with iron, which is added in the form of small iron particles. FIGURE 4.26 If the speed of the stone and the
curvature of its trajectory are great enough, the stone may become a satellite. (Magnetic fields also, which we'll learn about in the next chapter.) 13. Why the difference? But current in a branch never reduces to zero unless the resistance of the branch becomes infinite. Tensional forces create normal faults. 3 1 is that anticlines are pushed upward
into an arch, and synclines are pushed Anticline and syncline folds. Hewitt 422: (bottom right) Paul G. Such a nonpolar molecule (or to any other polar molecule), as Figure 15.35 illustrates. A REVIEW 365 70. You can hold your fingers on either side
of the rope at a node, and the rope doesn't touch them. Convergent boundaries are areas of compressive stress and, depending on the nature of the plate interactions, the recycling or destruction of lithosphere. You shine a beam of colored light to a friend up in a high tower. For example, you can extract chlorophyll from grass and note its color. What
is meant by the half-life of a radioactive sample? So whereas the liquid left behind is cooled with evaporation, with condensation the object upon which the vapor condenses is warmed. At this stage two distinct fronts develop: a warm front on the leading edge of the system, trailed by a cold front. Gas coma begins to form around nucleus when comet
is about 5 AU from Sun. Support force The force that supports an object against gravity, often called the normal force. C H A P T E R 18 18.1 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S Acids Donate Protons; Bases Accept Them EXPLAIN THIS Why are many pharmaceuticals treated with hydrogen chloride? Law of conservation of
energy Energy cannot be created or destroyed; it may be transformed from one form into another, but the total amount of energy never changes. And length contributes to resistance also. Heterogeneous mixture A mixture in which the different components can be seen as individual substances. The superscript 0 indicates that the electron's mass is
insignificant relative to that of protons and neutrons. When he removes the rubber head of the dart so it doesn't bounce when it hits the block, no tipping occurs. But another force, gravity, results in the net force being zero. Sound from a large bell has a low pitch because its vibrations are of same direction) from the tuning a low frequency. For
example, elemental nitrogen, shown in Figure 14.14, commonly consists of molecules containing two nitrogen atoms per molecule. The result is a two-monomer unit that has two terminal functional groups, one from each of the two original monomers. REVIEW 551 21. When a contracting ball of hot gas spins into a disk shape, it cools. Over time, these
particles are deposited on the inner surface of the bulb, causing the bulb to blacken. To create large amounts of these chemicals, the organic chemist devises a pathway through which the compound can be synthesized in the laboratory from readily available smaller compounds. A typical application of Pascal's principle for gases and liquids is the
automobile lift seen in many service stations (Figure 5.32). The answer is that everything is also absorbing energy. Accordingly, cesium is positioned at the far right of period 6, and so you can reasonably predict that its atoms are larger than those of radon, which is positioned at the far right of period 6. Railroad car A rolls at a certain speed and makes
a perfectly elastic collision with car B of the same mass. So when S-waves fail to traverse part of Earth's interior, a liquid phase is indicated. We saw earlier that a mediumsized star, such as our Sun, can collapse no further than a white dwarf because the force of gravity is not strong enough to overcome the resistance of electrons, which refuse to (a)
(b) trespass into the quantum states of neighboring electrons. When the cold front first overtakes the warm front, the two fronts meet at the ground, such that the warm air above each front no longer touches the ground, such that the warm front, the two fronts meet at the ground, such that the warm front, the two fronts meet at the ground, such that the warm front no longer touches the ground (Figure 25.14b). Iron 33.3 % Others 1.9 % Sodium 0.2 % Aluminum 1.5 % Calcium 1.8 % Nickel 2.0 % Oxygen 29.8 % Magnesium
Silicon 13.9 % 15.6 % Whole Earth toward the planet's center attracted even more debris. Cl Cl Toluene Naphthalene 1,4-Dichlorobenzene An example of an unsaturated hydrocarbon containing a triple bond is acetylene, C2H2. Polyatomic ion An ionically charged molecule. Rather than counting these particles individually, chemists can use a scale
that measures the mass of bulk quantities. An alternative method of indicating isotopes is to write the mass number as a subscript to the left of the atomic number as a subscript to the left of the atomic symbol. Sonic boom The loud sound resulting from a shock wave. Isolated animal species had to adapt to new environments; this resulted in new species
and increased animal diversity. Yet what gives a metal its metallic properties? Then drop the can on a rigid floor. But it does curve. The domains are microscopic (Figure 9.7), and there are many of them in a crystal of iron. But once cloud droplets form, the droplets are considerably denser than the air. Absorption of red produces the complementary
color, cyan. Because the molecule on the left is symmetrical, the dipoles on the two sides cancel each other. The fact that the orange simultaneously exerts a force on the apple, which is external to the system, may affect the apple (another system), but not the orange. (a) Ozone is destroyed upon binding to a CFC molecule that has been energized by
ultraviolet light. You can track the production of hydroxide ions by adding a pH indicator to the solution. The man stands on a low-friction turntable with weights extended. (F * d) in = (F * d) out 60 N * 1.2 m = W * 0.2 m W = [(60 N)(1.2 m)]/0.2 m = 360 N. Not significantly. His hypothesis, known as continental drift, stated that the world's continents
were once joined together as a single supercontinent that he called Pangaea. Energy is carried by the wave, traveling from one place to another. If they are in separate containers but bridged by a conducting wire, the electrons can flow from the iron through the wire to the copper ions. The Local Group is a relatively small cluster situated between
two larger clusters, the Virgo and Eridanus clusters. A change of phase from liquid to gas can also occur beneath the surface under proper conditions. At what point in its trajectory does a batted baseball have its minimum speed? A transformer has an input of 6 V and an output of 36 V. By "observable universe" we mean all that we are able to see
given the fact that the CHAP TER 27 S TA R S A N D G A L A X I E S 761 F I G U R E 2 7. Does a shell have to contain electrons in order to exist? (b) Explain why a satellite circling Earth above the atmosphere is in free fall. Hess hypothesized that the ocean ridges are located above upwelling convection cells in the mantle. And a truck at rest has no
momentum at all. Technology—The Practical Use of Science 14. Occupants in the ship would be able to stand on the floor and even jump up and down. Energy and Change of Phase 7.9 EXPLAIN THIS How does a refrigerator cool food? Atoms of the same element that contain different numbers of neutrons are isotopes of one another. Flotation Iron is
much denser than water and therefore sinks, but an iron ship floats. Up close, however, we see that this is an illusion. Now, you are George's cousin, not George 3.7 Power 23. (a) If you were so foolish as to play your keyboard instrument underwater, where the speed of sound is 1500 m/s, show that the wavelength of the middle-C tone in water would
be 5.86 m. Isostasy The process by which oceanic crust and continental crust come into vertical equilibrium, with respect to the mantle; the dense oceanic crust sits lower in the mantle than the less-dense continental crust. (c) Steel is a solid solution, a homogeneous mixture consisting of mostly iron plus smaller amounts of carbon and nickel
According to de Broglie, particles of matter behave like waves by virtue of their motion. And this gives us the third mechanism—namely, that rock can melt when its temperature rises, often because of the presence of hotter materials that have risen from deeper areas. Does a lunar eclipse occur at the time of a full Moon or a new Moon? They missed
the concept of inertia. (a) Protons are able to exist side by side within an atomic nucleus. The reason for water's high specific heat capacity involves the various ways that energy can be absorbed. So, their crystalline structure and properties are different. The majority of acetic acid molecules remain intact in their original non-ionized form, as shown
in Figure 18.8. Figures 18.7 and 18.8 show the submicroscopic behavior of strong and weak acids in water. Similarly, the book lying on the table compresses atoms in the table, which behave like microscopic springs. This is one of several similar radioactive series that occur in nature. In summer, heat flows from the hot air outside into the home's
cooler interior. 12.4 The Periodic Table LEARNING OBJECTIVE Interpret how elements are organized in the periodic table. They differ in density, composition, and thickness. Radioactivity is the ultimate source. If this is confusing, it may be well to note that Newton had difficulties with the third law himself. Caution: Do not try to mix vectors! We
cannot add apples and oranges, so velocity vectors combine only with acceleration vectors.
evident with a pressure cooker (Figure 7.30). Diffuse reflection in irregular directions from an irregular surface. In any chemical reaction, a specific number of products. (c) they can enhance the polarity of the organic molecule. In a diamond, light travels at less than half its speed in a vacuum.
only 0.41c. This is because light travels in waves, and atoms are smaller than the wavelengths of visible light, which is the light travels in waves, and (c) Earth. (c) insulators. The cork possesses no strange tendency to be drawn toward the water's
surface, and the gas possesses no strange tendency to rise. How soon before a new technology becomes assumed? With the ideal pulley system shown in Figure 3.32, the man VIDEO: Machines: Pulleys Output Input 500 N Input d=F d F FIGURE 3.31 This pulley acts like a lever with equal arms. Nucleus warms and begins to
sublimate. In other words, just as there should be the same number of atoms before and after the arrow of an equation, there should be the same charge. Ridge Transform faults allow two plates to slide past each other at places where two ridge segments are
offset. Thus, the greater the masses m1 and m2, the greater the force of attraction between them, in direct proportion to the masses.** The greater the distance between their centers of mass. Blow across the top of a sheet of paper as Tim does in
Figure 5.38. Kerosene, therefore, has the higher boiling point. 2 Absolute Zero 6. Much of the light reflected from nonmetallic surfaces is polarized. Likewise for golf balls. science? But great caution is advised when viewing the totality, which must be a totality of 100%. An apple falls because of the gravitational attraction to Earth. The bug must
—that is, a willingness to admit error. As Figure 17.4 illustrates, if you express the numeric value of the element having this mass is always 6.02 * 1023, which is 1 mole. 10.7 Interference 20. Which has more atoms: 17.031 g of ammonia, NH3, or 72.922 g of hydrogen
chloride, HCl? Which electrons are most responsible for the properties of an atom? The answer is simple enough—none; they all do. An owl moves its head as it glides toward its primarily methane, does not condense. Briskly rub a comb against
your hair or a woolen garment and then bring it near a small but smooth stream of running water. An important aspect of this model is that there are at least seven shells and each shell can hold only a limited number of electrons. (c) scattered. 4 8 Only the raindrops along the dashed line disperse red light to the observer at a 42° angle; hence, the
light forms a bow. In symbol notation: Ft = \mathbb{Q}(mv) Inelastic collision A collision in which the colliding objects become distorted, generate heat, and possibly stick together. As with evaporation, cooling of the liquid results. A discredited scientist does not get a second chance in the community of scientists. Are these three circuits equivalent to one
face to face, very little sound is heard. The brightness of the star diminishes with distance. The planets and all these other objects are quite small compared to the Sun. Where does our Sun reside on an H-R diagram? Gravity acts only downward, so the only acceleration of the ball is downward. This results in ice water being less dense than slightly
warmer water. He found that wave motion could be reduced to simple sine waves. The speed of electrons as they drift through a wire is surprisingly slow. FIGURE 3.32 Applied force * applied force * applied distance = output force * output distance. Guth realized that monopoles would become exceedingly rare if within an instant after the Big Bang, space expanded
in a dramatic burst. Because of the excellent conductivity of iron, large amounts of heat would injure your feet. (We imply this phenomenon when we say that water pressures—is maintained with the use of a suitable pump (Figure 8.18b).
Does Pascal's principle provide a way to get more energy from a machine than is put into it? Whereas a motor converts electric energy into mechanical energy into mechanical energy into electric energy into electric energy into mechanical energy into electric energy into electric energy into electric energy into mechanical energy into electric 
ethane, C2H6; hydrogen peroxide, H2O2; and acetylene, C2H2. The fist hits the bag (and dents it) while the bag hits back on the fist (and stops its motion). Because the pushed furniture is in equilibrium, can you see that the two forces combine to equal zero? The solution would be impossible to prepare because only a certain amount of acid can
dissolve in water before the solution is saturated and no more will dissolve. If all of the solar energy falling on a square meter could be harvested for power production, that energy would generate 1000 W. There are two kinds of matches: the "strike anywhere" type usually having a "bull's-eye" looking tip, and the "safety match," which requires you to
strike the match on a strip on the packaging. Earth's atmosphere is thin at the top and dense at the bottom. natural gas is methane, CH4, and one of the major components of gasoline is octane, C8H18. Interestingly, a 26-W CFL provides about the same light!**
In addition to significantly greater efficiencies, CFLs also have increased bulb lifetimes.† Incandescent bulbs are now being replaced by CFLs. A longer-lasting light source is the light-emitting diode (LED), the most primitive being the little red lights that tell you whether your electronic devices are on or off. When the Polaroids are crossed (b), no light source is the light-emitting diode (LED), the most primitive being the little red lights that tell you whether your electronic devices are on or off.
emerges because light passing through the first Polaroid is perpendicular to the polarization axes of the second Polaroid, with no components along its axis. But light can, because (as we discuss in Chapter 11) light Amplitude is a vibration of nonmaterial electric and magnetic fields—a vibration of pure energy. Much of this thermal energy conducts to
the surface and contributes to terrestrial radiation. The structure of acetylene is linear like a pencil with a triple bond between the two carbons. Knowing about chlorofluorocarbons and knowing how catalysts work, explain how this would not be a lasting solution. The unit of charge is called the coulomb, abbreviated C. 11.2 Transparent and Opaque
Materials 3. This greater impulse on the sail produces a net impulse in the forward direction, toward the right. What determines a rock's melting point? Show that the current in a 300-W bulb connected in a 120-V circuit is 2.5 A. This occurs when the negative charge is one atom away from an oxygen double bond as shown. In two doubling 12:01 P.M.
Bottles 1 and 2 are both full times, a quantity will 12:02 P. The property of a star that relates to the amount of energy per unit time it is producing is its (a) luminosity. For example, most of Earth's iron is concealed deep in the planet's interior, where it forms the central core. So 16 g of methane would yield 2 moles of water. By studying tree rings,
scientists have discovered that redwoods have played a significant role in removing CO2 from the atmosphere. C H A P T E R 13 T H E ATO M I C N U CL EU S A N D R A D I OAC T I V I T Y 325 CHECKPOINT Would you rather be exposed to 1 rad of alpha particles or 1 rad of beta particles? observed at the surface. Why does a July day in the Gulf of
Mexico generally feel appreciably hotter than a July day in Arizona, even when temperatures are the same? What is the extended forecast. FYI CHECKPOINT What determines whether a star becomes a white dwarf, a neutron star, or a black hole? Put on your safety
glasses and add several cups of tap water to a cooking pot. What happens is surprisingly dramatic! 42. Why is charge usually transferred by electrons rather than by protons? (c) terminates in the high-pressure center. As shown in Figure 16.17, for example, slightly positive and the oxygen the hydrogen bonds among water molecules are about as
strong as those beatoms are slightly negative. Many organic compounds contain one or more benzene rings in their structure. And the size and type of minerals in a metamorphic rock can reveal the rate of crystallization and the conditions of formation (the temperature and pressure) that occurred deep below Earth's surface. But the higher beat
frequency tells him he should have loosened the string. F I G U R E A .11 Conservation of angular momentum. But a diver falling in air at terminal velocity encounters air resistance and is not in free fall. Using the formula for gravity, show that the force of gravity on a 1-kg mass at Earth's surface is 9.8 N. But because of gravity, the projectile falls
beneath this line the same vertical distance it would fall if it were released from rest. (c) Suppose the distance d between wave crests is 1.8 m. 154 PARTONEPHYSICSFIGURE 6.1 3 Many ocean currents, shown in blue, distribute heat from the warmer equatorial regions to the colder polar regions. Early20th-century investigators
discovered that certain metals in a bath of liquid helium at 4 K lost all electrical resistance. For the same force, which cannon or a short one? 3.3 Conservation of Momentum 9. (c) its exhaust gases. (Hint: Consider Figure 8.8 back in Chapter 8.) 54. Are clouds that have vertical development
characteristic of stable air, stationary air, unstable air, or dry air? The ram of a pile driver, for example, interacts via gravitational force with Earth. But if the secondary has more turns than the primary, then greater voltage is induced in the secondary. Hewitt 367: Eric Schrader/Pearson Science 369: Science Photo Library/Photo Researchers, Inc. d,
8. The principal difference among radio, light, and X-rays is frequency. Distinguish between atomic number and mass number. H H H C C H H Ethanol H O H H H C H O H 61. In addition, changes in Earth's climate affect a fraction of the carbon-14 it origithe amount of carbon dioxide in the atmosphere. Velocity is a vector quantity. H2O is a
compound made of the elements hydrogen and oxygen in a 2-to-1 ratio. If, however, you reach over with one hand and grab a wire of different potential. The greater an atom's electronegativity, the greater its ability to pull electrons toward itself when bonded. What physics concept is Marshall demonstrating, and why is he careful that the broken
Cool air The refraction of sound occurs under water, where the speed of sound varies with temperature. Free fall Falling only under the influence of gravity—falling without air resistance. A low melting point means that the temperature does not need to be as high for the mineral to melt. Therefore, the height of the cloud base and how thick the cloud
becomes depend on three variables: the environmental lapse rate, the dry adiabatic lapse rate, and the moist adiabatic lapse rate. There are times, however, when weight corresponds to our unconscious notion of inertia. Structural isomers differ from each other and have different physical and chemical properties. If the temperature is 4°C and then
changes, why can't the thermometer indicate whether the temperature is rising or falling? Astronomical unit (AU) The average distance between Earth and the Sun; about 1.5 * 108 km (about 9.3 * 107 mi). 9.2 Magnetic Fields EXPLAIN THIS What is the origin of all magnetic fields? As we shall see in the next two sections, iron is an element, and rust
is a compound consisting of iron and oxygen atoms. O rganic compounds that contain only carbon and hydrogen atoms they contain. Discuss the role of distance. FYI 372 PA R T T W O CH E M I S T RY TA B L E 1 5 . 5. As shown in Figure 19.18, an
alkaloid reacts with an acid to form a salt that is usually quite soluble in water. Metal ores contain ionic compounds in which the metal atoms have lost electrons to become positive ions. How fast is the car approaching you, compared with the speed limit? Unlike water, the "top" of the atmosphere has no sharply defined surface. If a uranium nucleus
were to fission into three fragments of approximately equal size instead of two, would more energy or less energy be released? We could as well say that the buoyant force is 1 kilogram weight, not simply 1 kg. The word front is a military term used to describe the boundary between two different armies. Isaac Newton truly changed our way of viewing
the world. As plants and trees died, their remains sank to the bottoms of stagnant swamps. Notice that FIGURE 2.26 INTERACTIVE FIGURE In the larger system of orange + apple, action and reaction forces are internal and do cancel. Technological advances have recently brought us past the realm of microns to the realm of the nanometer (10-9 m),
which is the scale of individual atoms and molecules—a realm where we have reached the basic building blocks of matter. A pendulum swings to and fro every 3 s. Cold water is denser than warm water is denser than warm water. The galvanometer is named after Luigi Galvani (1737-1798), who, while dissecting a frog's leg, discovered that dissimilar metals touching the leg
caused it to twitch. 4.4 Universal Gravitation 12. But what about Earth's interior—what is going on inside our planet? Other familiar forms of precipitation are mist, hail, snow, and sleet. As you study this material, focus on understanding the chemical and physical properties of the various classes of compounds; doing so will give you a greater
sky be searched for a new planet. So cosmic inflation explains not only the uniformity of matter and energy in the universe, but how minor fluctuations gave rise to the cosmic structure we see through our telescopes today. How are electromagnetic waves produced? The Columbia Plateau in the Pacific Northwest is the result of extensive flood basalts.
(Figure 20.18), as is the Deccan Plateau in India. Consider the two forces acting on the person who stands still—namely, the downward pull of gravity and the upward support of the floor. Notice in our discussion of liquids that Archimedes' principle and the law of flotation were stated in terms of fluids, not liquids. It lies in a rain shadow. 147 1800 K
Iron melts 500 K Tin melts 400 K Water boils 300 K 273 K Ice melts Ammonia boils 200 K Dry ice vaporizes 100 K Oxygen boils -273°C 0 K FIGURE 6.5 Some absolute temperatures. H F H F The bonding electrons spend more time around the fluorine atom. This lineup is caused by a torque—a "turning force with leverage" (like
that produced by the weight of a child at the end of a seesaw). Many marine organisms make their shells out of calcite. It is possible to tow icebergs to coastal cities as a source of fresh water. F I G U R E 6 .1 9 Water molecules in a liquid are closer together than water molecules frozen in ice, in which they have an open crystalline structure. The
calcium and magnesium ions can do this because their positive charge (2 + ) is greater than that of the sodium ions (1 + ). If the water contains impurities, it should not be drunk. We detect this curvature as gravity. By Newton's third law, the force on the bug is equal in magnitude and opposite in direction to the force on the car windshield. Surface
water also deposits sediments as a stream's ability to carry sediments declines with speed. Therefore the way any atom behaves in the presence of other atoms is determined largely by the charged particles it contains, especially its outer electrons. Light orbiting at that distance is highly unstable. C H A P T E R 15 REVIEW 391 For instructor-assigned
homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Alloy A mixture of two or more metallic elements. What does this indicate about the relative strengths of these two forces? For example, would you sense there was a serious problem at 11:55 A.M., when the bottle was only 3% filled, (1/32), and had 97% of
open space (just yearning for development)? Proton A positively charged subatomic particle of the atomic nucleus. Electronegativity The ability of an atom to attract a bonding pair of electrons to itself when bonded to another atom. That is the role of an attentive government and a well-informed consumer. Deposition The stage of sedimentary rock
formation in which eroded particles come to rest. Let cool for 10 minutes. Then check your thinking below.) F I G U R E 1 .1 Galileo's famous demonstration. What are the most common igneous rocks, and where do they generally occur? As a field, it has matured greatly over the past hundred years, but it is still in a golden age of making new and
astounding discoveries. FYI During the next seven days, we see more and more of the Moon's sunlit side (position 2 in Figure 26.25). What is the principal difference between a step-down transformer? The present view of the universe has progressed appreciably beyond what Newton and those of his time perceived. How so?
A nebula does the same. Cosmology The study of the overall structure and evolution of the universe. Although every one of the interatomic forces is part of an action-reaction pair within the ball, they combine to zero, no matter how many of them there are. A radioisotope is placed near a radiation detector, which registers 80 counts per second. 280
mass, this explosion can be repeated multiple times. Pure oxygen has a greater concentration of one of the reactants (oxygen) in the chemical reaction (combustion). FIGURE 8.22 The electric field lines between the terminals of a battery are directed through a conductor, which joins the terminals. FIGURE 13.30 Mass per nucleon This graph shows
that the average mass of a nucleon depends on which nucleus it is in. A A B C B C 212 PA R T O N E P H Y S I CS 66. 5 Magnetic Forces on Moving Charges 9. The heat energy generated in 1 min is E = power * time = (1008 J/s) (60 s) = 60,400 J, or about 60 kJ. When lightning strikes, nitrogen molecules, N2, and oxygen molecules, O2, in the air react
to form nitrates, NO13 - , which come down in the rain to help fertilize the soil. The reaction shows the formation of a single molecule from three molecules plus two atoms. 15.8 Molecular Attractions EXPLAIN THIS S Is it possible for a fish to die from drowning? At that time, horses and buggies were yielding to steam-driven locomotives. (d) as large
as its photon sphere. A sustained electric current requires a suitable pumping device to maintain a difference in electric potential—to maintain a voltage. We don't sense them because the positives and negatives normally balance out, and, even for objects charged to a high voltage, the imbalance of electrons to protons is typically no more than one
part in a trillion trillion. A chemical equation for the combustion of propane, C3H8, is shown. As shown in Figure 26.17, deep beneath this ice is likely an ocean of water kept warm by the strong tidal forces from nearby Jupiter. Molecule a is an ether, which has limited solubility in water. Light ray X-ray Gamma ray FIGURE 13.3 INTERACTIVE
FIGURE A gamma ray is simply electromagnetic radiation, much higher in frequency and energy than light and X-rays. Because light travels faster in thin air than in dense air, parts of the wavefronts of F I G U R E 11. It is simply the weight of the fluids directly above you—water plus air— pushing against you. Clouds are always moving up. Why is the
lettering on the front of some vehicles—for example, ambulances—"backward"? Many people believed that Earth was so large that its resources were virtually unlimited and that it could absorb wastes without being significantly harmed. When the ice mass is 50 m thick, it becomes a glacier as it moves under its own weight. Stromatolites and other
fossils found in rocks are known to be Precambrian in age. Then jump vertically and make another mark at the highest point. Even under high pressure, foliation cannot develop if the rock to stress depends on temperature, pressure, and
the composition of the rock. Star A, therefore, is brighter because it is closer to us. For this reason 1-pentanol is not very soluble in water. Rank the beat frequency from highest to lowest for the following pairs of sounds: (a) 132 Hz, 258 Hz; (b) 264 Hz, 258 Hz; (c) 528 Hz, 531 Hz; and (d) 1056 Hz, 1058 Hz. E X E R C I S E S (SYNTHESIS) 66. Ethers
are not very soluble in water because without the hydroxyl group they are unable to form strong hydrogen bonds with water (Section 15.8). There is no atmosphere on the Moon, so the sky appears black and even dim stars are visible. The pair of forces occurs simultaneously. Its surface temperature is cold, roughly -170°C. The waveform is actually a
sine curve, a pictorial representation of a a sine curve on the paper, which wave. (What should you do to answer this question?) 84. Governments and manufacturers are now working to phase out these plasticizers. 2 The night side of Earth always faces away from the Sun. 3 0 Shown in black and white is the ground-telescope view of an irregular
galaxy resulting from the collision of two galaxies. Are new materials being formed as Evan grows? Hold one jellybean while rotating the other. Want to see the history of our universe? Because this region is so densely populated, as many as 70 million people may be subject to some level of arsenic poisoning, which manifests itself as skin lesions and are not a subject to some level of arsenic poisoning, which manifests itself as skin lesions and are not a subject to some level of arsenic poisoning.
higher susceptibility to cancer. The refrigerator! Microorganisms, such as bread mold, are everywhere and difficult to avoid. As the occlusion continues to grow (Figure 25.15e), more and more warm air is displaced upward, until there is no significant temperature difference horizontally across the storm. Dipole-induced dipole attractions are also
responsible for holding plastic wrap to glass, as shown in Figure 15.37. If the buoyant force decreases, it will move downward; if it increases, the balloon will rise. Step 3: Lay plastic wrap loosely across the top of the pot and secure it with a rubber band. If the elevator accelerates upward, the springs inside the bathroom scale are more compressed
and your weight reading is greater. You should therefore be careful not to interpret any visual representation of an atomic conceptual model as a re-creation of an atomic atomic and your weight reading is greater. You should therefore be careful not to interpret any visual representation of an atomic conceptual model as a re-creation of an atomic atomic and your weight reading is greater. You should therefore be careful not to interpret any visual representation of an atomic conceptual model as a re-creation of an atomic 
effectively cleans the penny. From deserts to glaciers, a variety of creatures have invented ways to survive the harshest corners of the world. As the north side of the bowl? The corona is the hottest. And the reason is the law of mass conservation, which tells us that
atoms are neither created nor destroyed in a chemical reaction—they are simply rearranged. Lower a narrow glass tube or drinking straw into water and place your finger over the top of the tube. These six electrons may be picked up by three oxygen atoms, transforming the atoms to three oxide ions, O2-. The surface of Venus was first mapped in the
early 1990s by the spacecraft Magellan, which used microwave radar ranging to "see through" the planet's thick atmosphere of carbon dioxide and sulfuric acid clouds. The orientation of reactant molecules in a collision can determine whether a reaction occurs. So we find dry, high-temperature minerals, such as garnet and pyroxene, at the contact.
To find the solution (distance), we need to know the time period and the rate of movement. If a Geiger counter that is 1 m away from a small source reads 100 counts per minute, what will its reading be 2 m from the source? When two horizontal forces are exerted on the car in the preceding problem, 220 N forward and 180 N backward, the car
undergoes acceleration. Does that mean that an incandescent bulb wastes electricity? The h = density * g 1.2 kg/m3 * 10 N/kg top of the atmosphere would be about 8.3/40 or 0.2 of the almost-top of our atmosphere. LEARNING OBJECTIVE Define acceleration, and distinguish it from velocity and speed. ? With eternal inflation, the ultimate fate of our
own observable universe is not the same as that of the universe as a whole. Assume there were no active volcanoes on or around Kauai during these times. Because of this extra reflection (and extra refraction loss), the secondary bow is much dimmer and reversed. Where the lines are closer together, the field is stronger. Gradebook Diagnostics This
screen provides your favorite weekly diagnostics. These two factors increase the travel time to the surface for the mantle-derived basalt. The energy of wind can be used to turn generator turbines within specially equipped windmills. Fibers of polypropylene are used for upholstery, indoor- outdoor carpets, and even thermal underwear. What is the
net force that acts on a 10-N falling object when it encounters 4 N of air resistance? Which is larger: a Celsius degree or a kelvin? You could say that, in a sense, you are hit by a "water boom." In the same way, when the conical shell of compressed air that sweeps behind a supersonic aircraft reaches listeners on the ground below, the sharp crack
they hear is described as a sonic boom. Fracture A break that does not occur along a plane of weakness. If you throw it with the same speed into a sagging sheet, the egg won't break. What two principal factors affect the force of air resistance on a falling object? Research that focuses on
developing these applications is known as applied research. The San Andreas Fault stretches for 1500 km from Cape Mendocino in northern California to the East Pacific Rise in the Gulf of California. White light Narrow slit Atoms in filament excited by electricity (a) Smooth, continuous spectrum from white light (b) White light directly from light northern California to the East Pacific Rise in the Gulf of California.
source Smooth, continuous spectrum from white light (mirror image) C H A P T E R 12 Light is given off by atoms subjected to various forms of energy, such as heat or electricity. A scanning probe microscope shows only the relative sizes and positions of atoms. CHECKPOINT An internal-combustion engine works by drawing a mixture of air and
gasoline vapors into a chamber. The remedy, of course, is to swallow specially coated aspirin tablets, which delay the release of the aspirin until after it passes through the stomach. H3O H3O 1800 H3O 1900 H3O
the reactor is above 100°C. VIDEO: Resonance VIDEO: Resonance and Bridges (a) Find the frequency of the waves. Hewitt 278: (bottom) Paul G. When a row of people locked arm in arm at the skating rink makes a turn, the motion * Physics types usually describe rotational speed in terms of the number of "radians" turned in a unit of time, for which
they use the symbol v (the Greek letter omega). TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool.* A dramatic example of cooling by expansion occurs with steam expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool. TUTORIAL: Stellar Evolution VIDEO: Lives of Stars 746 PA R T F O U R ASTRONOMY Was this your answer? To see for yourself that expanding air really does cool.
through the nozzle of a pressure cooker (Figure 7.8). (c) 14 billion years old. a, b, c. Can you see evidence of gravity acts on there is no net impulse and thus no change in momentum. Once one's feet are off the ground, only the force of gravity acts on the
jumper (neglecting air resistance). Thus far, we have treated mass as a measure of inertia, which is called inertial mass. Rather than being placed adjacent to hydrogen, H, however, helium is placed on the far right of the table. As a result, there is very little wind and weather on the surface of Venus. Processing recycled alum
consumes only about 700 kWh for every ton. Africa's Great Rift Valley is in this stage today. In the next chapter we describe how dark matter likely played a key role in the formation and distribution of galaxies. 5HVXOWVGRFXPHQWHGLQVFLHQWL¿FDOO\YDOLGHI¿FDF\SDSHUVDUHDYDLODEOHDW www.masteringphysics.com/site/results
ENGAGING EXPERIENCES MasteringPhysics® provides a personalized, dynamic, and engaging experience for each student that strengthens active learning. For a car that now costs $30,000? The upper part of the lithosphere—the crust—responds to stress in two ways: by breaking (faults) and by flowing (folds). When a 10 and it contracted gas was
cooled from 0°C to - 10°C, its volume decreased by 273 263 to 273 of its original volume. How about an oxygen molecule? Heat transfer and the TO THE INSTRUC TOR differences in seawater density across the globe set the stage for discussions of atmospheric and oceanic circulation and Earth's overall climate. 126 PA R T O N E P H Y S I CS
PHYSICS IN HISTORY Archimedes and the Gold Crown According to legend, Archimedes (287-212 BC) had been given the task of determining whether a crown made for King Hiero II of Syracuse was of pure gold or contained some less expensive metals such as silver. The universe is expanding. See also Dipoles formation of, 368-372 polyatomic
372 Ionic bonds, 372-375 Ionic compounds, 372 Ionized bracelets, 190 Ionosphere, 662 Irregular galaxies, 756-757 Isomers, structural, 491 Isostasy, 560-561 Isotopes, 298-299 in radiometric dating, 625-626 J Jumping, 30 hang time and, 102 Jupiter, 710, 718-719 K Karst regions, 599 Ketones, 503 Kilogram, 17, 19 Kinetic energy, 73 vs. (b)
transformations of matter. Use the shell model to explain why a potassium atom, K, is larger than a sodium atom, Na. 82. 714: (bottom) NASA Earth Observing System 718: NASA Earth Observing System 717: (top) David A. Reverse osmosis A technique for purifying water
by forcing it through a semipermeable membrane into a region of lower solute concentration. First of all, a rainbow is not the flat two-dimensional arc it appears to be. Why is it more accurate in the case of a parallel circuit to say that most current travels in the path of least resistance? They have existed through imponderable ages, recycling through
the universe in innumerable forms, both nonliving and living. In which of these two months is Earth moving faster around the Blood Seawater lower its pH. Hence the water level is unchanged. A certain radioactive element has a
half-life of 1 h. CHAPTER 22 1. Which elements make up the carbonyl group? The next closest major galaxy, the Andromeda galaxy, is about 2.3 million light-years distant. Unless noted otherwise, continue to assume that Kw is a constant 1.0 * 10-14; in other words, assume that the solution being measured is at 24°C 61. The second set contains 2
dimes and 25 pennies. Compared with the change in momentum of the bug, by how much does the momentum of your car change? If a magma contains molten forms of mineral A (30% silica), which would crystallize first as the magma contains molten forms of mineral B (25% silica), which would crystallize first as the magma contains molten forms of mineral B (25% silica).
(provided they don't join in a chemical bond, as is discussed in Chapter 15). A common science model views electrons as spinning about their own axes like tops, while they revolve about the nuclei of their atoms like planets revolving around the Sun. The type of iron that the human body needs for good health is the Fe2 + ion. Does a moving object
have momentum? As expected, the crust is composed of mostly lighter elements. Why don't oil and water mix? Because of this behavior, the strip bends as shown. Coriolis force The apparent deflection from a straight-line path observed in any body moving near Earth's rotation. (c) Two, TiO2 is a mixture of Ti and 2 O. But,
again, testimonials are another story. At a mere depth of 30 km the temperature is hotter than 500 to note that for many moons orbiting other planets, a single hemisphere faces the planet. Relate to the fact that at the same
temperature, water-vapor molecules have the same average kinetic energy as the heavier nitrogen and oxygen molecules in the air. amine 8. What is the advantage of squeezing the vapors to a smaller volume? By convention, the subscript 1 is understood C H A P T E R 14 Atomic symbol for nitrogen Atomic symbol for gold Au E L E M E N T S O F CH
E M I S T RY 357 Atomic symbol for carbon C N A gold atom A nitrogen atom in a nitrogen atom of atom. She is now 5 meters from the fulcrum, and the seesaw is still balanced. What is released by an exothermic
reaction? Explain with a sketch how the curvature of the bite indicates the size of Moon. Beats arise from such alternation between constructive and destructive interference. (d) The sample is being heated and the material is boiling. At such high altitudes, horizontal winds and lower temperatures flatten and stretch the
thunderhead crown into a characteristic anvil shape (Figure 25.17). (a) Energy to break bonds Energy released from bond formation N i N = 436 kJ N i H = 43
absorbed - 2690 kJ released = -975 kJ released (exothermic) (b) Energy to break bonds Energy released from bond formation O i O = 138 kJ H i O = 464 kJ O i H = 464 kJ O i 
2132 kJ absorbed - 2354 kJ released (exothermic) 43. But this speed is insufficient for the box to fall around and around Earth. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 106. They did not know that the mantle has a "plastic-like" layer, the asthenosphere, over which "floating" continents can readily slide. Note as
you bring the ball closer to the Sun, the crescent on the ball gets thinner. Cosmic inflation The moment of the sudden and brief burst in the size of the universe immediately after the Big Bang. A vacuum pump simply provides a region of lower pressure into which the normally fastmoving gas molecules randomly move. Just as all solar eclipses involve
a new Moon, all lunar eclipses involve a full Moon. And when the siren passes you and moves away, the crests of the waves encounter your ear less frequently, and you hear a drop in pitch. A three-minute boiled egg in Denver is yucky. 214 PA R T O N E P H Y S I CS 109. When we turn on a light, we give little thought to the centrally controlled power
grid that links the widely separated power stations by long-distance transmission lines. Einstein failed to predict the dynamic nature of the universe. KF is potassium fluoride. People who can't float are, 9 times out of 10, males. 344 PART WOCHEMIS TRY 13.6 Mass-Energy Equivalence 19.8 Melting and Freezing 7. This ooze eventually
crystallizes into calcite, which then forms limestone. Hewitt 30: Zsports/NewsCom 38: CHAPPUIS Blaise/AGE fotostock 40: World History Archive/ Newscom 44: (top) Oliver Furrer/CORBIS 44: (bottom) Richard Megna/ Fundamental Photographs, NYC 51: Shutterstock 52: Paul G. (c) nonpolarity is greater. O Benzene ring OH O O Aspirin 496 PA R T T
W O CH E M I S T RY Was this your answer? 7 Dynamic Equilibrium 1. A coefficient in front of a chemical formula tells us the number of times that element or compound must be counted. What does the spin rate of a star have to do with whether or not it has a system of planets? C H A P T E R 17 H O W CH EM I C A L S R E AC T 429 This equation
for the formation of water is also balanced—there are four hydrogen and two oxygen atoms before and after the arrow. The cold air forces the warm air upward, where it condenses to form clouds. Conversely, the acid donated a hydrogen ion and thus lost a positive charge. A currently accepted model is that because Mars is such a small planet, its
molten core cooled down and solidified relatively fast—within a billion years of formation. The nebular theory is based on the observation that the solar system (a) follows patterns indicating that it formed progressively from physical processes. These crystals divide unpolarized light into two internal beams polarized at right angles to each other. Does
a moving object have impulse? At the instant that a high-pressure region is created just outside the prongs of a vibrating tuning fork, what is being created inside between the prongs? In a nonpolar bond or molecule, the electrons are distributed evenly. 1 2 3 4 Inner transition metals 5 6 7 The seventh-period inner transition metals are called the
actinides because they fall after actinium, Ac. They, too, all have similar properties and hence are not easily purified. (Velocity, however, is 50 m/s at 5 s and 100 m/s at 5 s and 10
So the work output is only 40 J, and the pulley system has an efficiency of 40%. I f the two atoms in a covalent bond are identical, their nuclei have the same positive charge, and therefore the electrons are shared evenly. The study of sciences and the physical sciences
When a javelin or a shot is thrown, a significant part of the launching gravity—so launching at 45° means a lower launching speed. No, you cannot. At first this may seem strange, for when we wonder about most things, we concern ourselves with ways of finding out whether they are true. Note that shaking at a low
frequency produces a long, lazy wave, and shaking at a higher frequency produces a wave of shorter wavelength. Perhaps small particles of gas and dust stuck together via gravity or electrostatic attraction. Earth's elements separated according to density. By 1910, as disinfecting drinking water with chlorine became more widespread, the death rate
from typhoid fever dropped to 20 per 100,000. If cooling did not occur, continued application of heat to a pot of boiling water would raise its temperature. (c) the same mass per nucleon. Na+ H HO H H N HO O− O + CH 3 Cl≥ O Na+ −O N O OH HO Phenylephrine-hydrochloric acid salt 56. When brightness diminishes, shake again. Why doesn't a
piece of solid water (ice) sink in a container of "molten" (liquid) water? Daughter Maitreya is seen eyeing ice cream on page 489 and brushing her teeth with her dear friend Annabelle Creech on page 373. He Si 3 Zinc has a low melting point and is commonly used in making coins. This reaction is endothermic because it requires an input of energy. In
the mid-1980s, researchers developed the scanning probe microscope, which produces images by dragging an ultrathin needle back and forth over the surface of a sample. Glaciers moving across a landscape loosen and lift up blocks of rock and incorporate them into the ice. Which hits the ground first? (b) liquid phase. This does not mean that
thermal energy necessarily flows from a substance with more thermal energy into one with less thermal energy. Contributions were made to the physics chapters by renowned physicist Ken Ford, who shows his passion for flying on page 250. The properties of space surrounding any mass are altered such that another mass introduced to this region
experiences a force. Rank the boiling-water temperature from highest to lowest in these locations: (a) Death Valley, (b) Sea level, and (c) Denver, CO (the "mile-high city"). Art is about cosmic beauty. Sometimes, two or more minerals contain the same elements in the same proportions, but their atoms are arranged differently. FIGURE 26.45 (a) (b)
Comet Shoemaker-Levy was already broken up into a string of objects just before it collided with Jupiter in 1994. Oceanic crust is thin and composed of dense basaltic rocks. 397: (middle) John Suchocki/Paul G. The pupil of the eye, for example, allows light to enter with no reflection, which is why it appears black. TA
BLE1. Which has the greater density—5 kg of lead or 10 kg of aluminum? So the temperatures on Mars are generally colder than on Earth, ranging from about 30°C in the day at the equator to a frigid -130°C at night. 174 PARTONE PHYSICS LEARNING OBJECTIVE Describe the relationship between energy and phase changes. The most
obvious evidence is the matching of the edges of the African and South American continents, which can be seen on any world map or globe. Wegener's evidence was the "jigsaw puzzle" fit of continents, which can be seen on any world map or globe. Wegener's evidence was the "jigsaw puzzle" fit of continents, which can be seen on any world map or globe.
related by Einstein's equation E = mc 2. (a) no, because the reis no acceleration (b) yes, even though the gravity is artificial 7. When you touch your fingers (resistance 1000 \( \) to the terminals of a 6-V battery, show that the small current
moving through your fingers is 0.006 A. Show that the mountain is almost 5000 km distant. The collapse continues beyond the stage of a neutron star, and the star disappears altogether from the observable universe. Because water molecules are so tightly held in a solid, frozen water sublimes much more slowly than liquid water evaporates. How high
will a balloon rise? Draw all the structural isomers for amines that have the molecular formula C3H9N. Why is there a lower limit on the mass of a star? Willis/USGS 575: B. Hewitt 700: Eric Nguyen/Photo Researchers, Inc. Newton tells us that gravitational force acts on all bodies in proportion to their masses. Igneous rocks formed by the eruption of
molten rock at Earth's surface are called volcanic (or extrusive) rocks. Which likely has more mass: the air we exhale? 13.2 The Strong Nuclear Force 5. Underlying biology is chemistry, and underlying electrons,
losing oxygen atoms, or gaining hydrogen atoms. In accord with the inverse-square law, at three times the distance, the force decreases to 19 its original value. Rank the circuits according to the brightness of the identical bulbs, from brightnes
by you at the rate of three cars each second, what is the speed of the train? At a certain point, the temperature becomes high enough in the core to launch helium burning—the fusion of helium to carbon. A 1-L container completely filled with lead has a mass of 11.3 kg and is submerged in water. If her hand is made to bounce upon impact, as we will
soon see, the force is even greater. His rotational speed increases!* This example is best appreciated by the turning person, who feels changes in rotational to the resistance R. Using Planck's quantum hypothesis, the Danish scientist Niels Bohr (1885-
1962) explained the formation of atomic spectra as follows. When the loudness increases, the amplitude of the waveform increases. Electric power in your home is likely supplied at 60 Hz and 110-120 V through electrical outlets. Now do you know how a geyser and a coffee percolator operate? As lightning heats up the air, the air expands and we
hear lightning's noisy companion—thunder. Rank the speed of sound through the following media from fastest to slowest: (a) air, (b) steel, (c) water. By definition, chemistry is the study of matter and the transformations it can undergo. This is because the
charge on the balloon alters the charge distribution in the atoms or molecules in the wall, effectively inducing an opposite charge on the wall. Divergent boundaries have thermally metamorphosed rocks. This photo was taken by the Hubble Telescope. Regarding Exercise 83, you exert a force on the boat (action), and the boat exerts a force on you
(reaction). After you answer the following Checkpoint, we'll explore why. Because electron waves are much shorter than visible-light waves electron microscopes, as Figure 12.27 shows. If a scientist finds evidence that contradicts a hypothesis, law, or principle, the scientific spirit requires that the
hypothesis be changed or abandoned (unless the contradicting evidence, upon testing, turns out to be wrong—which sometimes happens). (c) irregular. In this case, the denser oceanic plate subducts beneath the less-dense continental plate. PARTTWOCHEMISTRY 4. The lower body contains liquid ether, which evaporates rapidly at room
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temperature. Common names are more convenient to use than systematic names. Pour this extract into a large transparent container, such as a vase or a 2-L plastic bottle with the top cut off. This is similar to the way that sound is transmitted (Figure 11.4). A galvanometer may be calibrated to measure current (amperes), in which case it is called an
 ammeter. Produced as an extension of a powerful thunderstorm, the funnel cloud is called a tornado only after it touches the ground. (a) lead (b) platinum (c) polonium (d) thallium 6. Temperature rises as the burned-out hydrogen core contracts because of gravity. To attain the greatest amount of KE for escape using a given amount of fuel, should it
fire its engines at the apogee (the point at which it is farthest from Earth) or at the perigee (the point at which it is closest to Earth)? (b) v = 0.00 to couples. Herapathite is such a crystal. Why might the window shatter in a strong wind blowing past? Damage generally occurs by
excess heating when too much current is driven through an appliance. Your friend is correct! In addition, there are atoms in your friend's and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and everyone else's body that were once part of Einstein and Eins
electromagnetic waves? The next time you find yourself admiring a crisp blue sky, or delighting in the shapes of bright clouds, or watching a beautiful sunset, think about all those ultratiny optical tuning forks vibrating away. FIGURE 10.45 Sounds from the piano and clarinet differ in quality. The fact that it remains at rest indicates that 50 N isn't
great enough to make it slide. In Figure 9.17, we see a magnet exerting a force on a current-carrying wire. All forms of moving water are assisted by gravity—groundwater, rivers and streams, and ice. He formed the following hypotheses: 1. Why did this fracture the boulders? (b) has only one electron to share. TUTORIAL: Intermolecular Forces As is
indicated in Figure 15.6, the attraction between an atom's nucleus and its valence electrons is weakest for elements on the +9 +9 right. Plate tectonics The theory that Earth's lithosphere is broken into pieces (plates) that move over the asthenosphere; boundaries between plates are where
most earthquakes and volcanoes occur and where lithosphere is created and recycled. The ancient Greeks called this diffuse band of light the Milky Way. (c) The diethyl ether-insoluble caffeine salt would form as a white precipitate. Helium is formed underground as a by-product of radioactive decay. Biology is based on the principles of chemistry as a white precipitate.
applied to living organisms, while chemistry is based on the principles of physics as applied to atoms and molecules. I was then interested in drawing comic strips and in boxing, neither of which earned me much success. Some of the light here is reflected (not shown), and the remainder is refracted into the water. 3 Functional Groups 19. What occurs
is described in Chapter 7 (p. Parts of San Francisco on rigid bedrock had small wave amplitudes, so very little damage occurred to structures built on bedrock. When the wires in the spinning armature cut through the magnetic field, oppositely directed electromagnetic forces act on the negative and positive charges. Figure 15.31 describes an
interesting example. No, no, no! This is contradictory only if the same element is said to release energy by both the processes of fission and fusion. What does a catalyst do to the energy of activation for a reaction? For thousands of years, people have gazed into the night sky and pondered questions such as these. 471 F I G U R E 1 8 .1 8 In the
exothermic formation of sodium chloride, sodium metal is oxidized by chlorine gas, and chlorine gas is reduced by sodium metal. (2) This electron transfer results in two oppositely charged ions. So Ft = @mv = (16 kg # m/s) - 0 = An ostrich egg of mass m is thrown at a speed v into a sagging bedsheet and is brought to rest in time t. The resulting
acceleration of a falling object is evident, while the upward acceleration of Earth is too small to detect. Interaction Mutual action between objects during which each object exerts an equal and opposite force on the other. Your friend smells cinnamon coming from an inflated rubber balloon containing cinnamon extract. Two teams of horses couldn't
pull the evacuated hemispheres apart. Adiabatic processes occur when air is expanded or compressed. The dates of meteor shower might be, however, is still somewhat of a guess. From greatest to least, rank them by the number of (a) protons in the nucleus, (b) neutrons in the
nucleus, and (c) nucleons in the nucleus. A stone is thrown upward at an angle. This coguina, composed of shells and shell fragments, is a fossiliserous limestone—full of fossils! FIGURE 20.31 Fossils: Clues to Life in the Past Because sedimentary rocks (clastic and chemical) form at Earth's surface, they often contain the remains of life forms—fossils
Twice the voltage would produce twice the current if the resistance of the filament remained the same. Twice as much weight when weighed in the same location? For a neutral solution of supercritical water, the pH equals about 2, which means that it is highly corrosive. What is a chemical bond? After that, expansion overrides contraction because
most of the ice crystals have melted (Figure 6.22). READINGCHECKQUESTIONS (COMPREHENSION) 25.1 Atmospheric Moisture 1. Radioactive Tracers FIGURE13.1 0 The thyroid gland, located in the neck, absorbs much of the iodine that enters the body through food and drink. Humidity A measure of the concentration or amount
of water vapor in the air: the mass of water vapor per volume of air. A good example is the nutrient beta-carotene. The (a) Heterogeneous mixtures atmosphere we breathe is a gaseous solution consisting of the gaseous elements nitrogen and oxygen as well as minor amounts of other gaseous materials. You might hear, for example, that gold is an
 element made of gold atoms. Compared with terrestrial radiation, the radiation, the radiation from the Sun has a (a) longer wavelength. One reason for this has to do with a feature that the boat to ensure that the boat will knife through the water only in a forward (or
backward) direction. Eclipses Although the Sun is 400 times as large in diameter as the Moon, it is also 400 times as far away. Smalley emphasized that chemists already know how to combine atoms (in bulk) to create novel molecules (also in bulk). Rather, some unknown form of energy is causing an increase in the rate at which galaxies are receding
GPS data shows that land near the epicenter is 13 feet (4 m) wider than before, and some areas of northeastern Japan are closer to North America by about 2.4 m (7.9 ft). When a magnet is repeatedly plunged into and back out of a coil of wire, the direction of the induced voltage alternates. If you tossed a baseball horizontally and with no gravity, it
would continue in a straight line. Is there enough oxygen to react with all of the methane? In a stretched rubber band, elastic deformation is observed after it is released—it returns to its original shape. (c) Marble and slate are metamorphic rocks. This period matches the period of daily Earth rotation. What is a clastic sedimentary rock? At this stage
warm air is in contact with the ground, between the two fronts (Figure 25.14a). The buoyant force that acts on a 20,000-N ship is (a) somewhat less than 20,000 N. No force in the direction of the shuttle's motion exists. Impulse is a very weak base, as
evidenced by the unlit lightbulb in Figure 18.9a. The term lava refers both to the molten rock itself and to the solid rocks that form from it. Hitting askew, the impact sent Earth into a wild spin rotating once every five hours. Mass = concentration * volume = (3.0 g/L)(15 L) = 45 g. (c) Shake with three times the frequency and produce three loops (32 given by the impact sent Earth into a wild spin rotating once every five hours.
wavelengths). In Appendix A we'll see that angular momentum is conserved—whatever the rotational motion of a planetary system, its angular momentum remains unchanged so long as it is free of outside influences. The charges with sodium chloride are all balanced—for every positive sodium ion there is a corresponding negative chloride ion. The
point of support on which a lever rotates is called the fulcrum. 4 Net Force 1. Phenol damages healthy tissue, however, and so a number of milder phenols have since been introduced. The great pressures deep in a star's interior cause hydrogen atoms to fuse into heavier atoms. So the base forms the positively charged ion. It would take you 31,800
 years to count to a trillion. Formula mass The sum of the atomic masses of the elements in a chemical formula. Generally speaking, whenever any fluid (liquid or gas) interacts with a smooth surface, the force of interaction is perpendicular force on the sail, but
is constrained to move in a forward (or backward) direction by its keel. Are the physical and chemical properties of a compound necessarily similar to those of the elements of which it is composed? An ellipse can be easily constructed by using a pair of tacks (one at each focus), a loop of string, and a pencil (Figure 4.32). Religion is about cosmic
purpose. The barometer "balances" when the weight of liquid in the tube exerts the same pressure as the atmosphere outside. These terms were coined by miners because one could hang a lamp on a hanging wall, and one could stand on a footwall. The given pair of forces produce a net force of 220 N - 180 N = 40 N forward, which accelerates the
car. If the aircraft is to fly at constant velocity at constant velocity at constant altitude, then lift must equal the weight of the aircraft and the thrust of the plane's engines must equal to the nucleon that is pulled out. The relationship between buoyancy and displaced liquid was first discovered
in the third century BC by the Greek scientist Archimedes. (d) B, A, C. Together, these bubbles, known as Fermi bubbles, extend about 50,000 lightyears, which is about half the diameter of our galaxy. Show that the gravitational force between them stays
the same. Jump in and sink and immersion is total—you're submerged. (Heavier elements such as those found on Earth are very minor contributors to the total amount of matter in the universe.) Hydrogen is the simplest of all elements, consisting of a single proton nucleus. 22 8 2 13 0 2 0 Nov. The wool, in turn, has a deficiency of electrons and is
positively charged. Thus, surface rocks are not representative of the planet's interior. (b) each heteroatom has its own characteristic chemistry. This publication is protected by Copyright and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any
means, electronic, mechanical, photocopying, recording, or likewise. 3 Half- Life and Transmutation 13. Magnetite can be gray or brown to black, but F I G U R E 2 0 .1 0 it always makes a black streak. A D B C 72. LIGHT 285 (a) (b) F I G U R E 2 0 .1 0 it always makes a black streak at 220 V.) 115. (The names of the units are
often abbreviated: V for volts, A for amperes, and \(\frac{1}{2}\) (the capital Greek letter omega) for ohms. This occurs in instances do not. (a) This is very much like the preceding problem. These resemble a standing wave centered on the atomic nucleus. Anode The electrode where chemicals are oxidized. Unless its grip on your skin is strong enough after
landing, it must continue flying at 3 m/s to keep from being blown off. And so when you see the light emitted by a very distant object, you are actually seeing the light it emitted long ago—you are looking back in time. 62. Our unfortunate astronaut would have passed within the event horizon, the boundary where no light within can escape. In the
mantle, however, most of the heat flow is due to convection. (b) The general public understands the pH scale. What is left is a black hole. Because the density of water is 1/13.6 that of mercury, a water column needs to be 13.6 times taller than a mercury column to have the same weight and produce the same pressure. It also rotates much more
slowly. Carbon dioxide dissolves in the ocean. 72. 755: (top) Adam Evans/Flickr 755: (bottom left) NASA, ESA, and the Hubble Heritage Team (STScI/AURA) 756: (bottom right) NASA/Jet Propulsion Laboratory 757: (top) NASA/Jet Propulsion
Laboratory 757: (middle) NASA/WikiSky 757: (bottom left) National Optical Astronomy Observatories 757: (bottom right) A. How would Galileo explain it? The force of the atmosphere is on both sides of the window; the net force is zero, so windows don't normally shatter under the weight of the atmosphere. So water has a much higher specific heat
capacity than metals—and most other common materials. Perpetual motion is the natural order of things. Astronauts in orbit are without a support force and are in a sustained state of weightlessness. There are three main types of rock. Is it possible for crystallization to enrich magma in more than just silica? Block B is supported by two strands of
string, each 100 N, which means the mass of block B is twice that of block A. Temperatures don't continuously decrease because all objects are also absorbing radiant energy. The two kinds of motion are electron spin and electron spin and electron revolution about the nucleus. Yes, because the molecule has two reactive ends. Stream gradient, stream discharge, and
channel geometry. Working backward from the present, scientists estimate a temperature in excess of 100 billion K within a few seconds after the Big Bang. If the boat is somehow propelled to a speed faster than the wind (by way of a motor, for example), then air resistance against the front side of the sail will produce an oppositely directed force
vector. Chemist Rick Smalley (1943-2005), however, was quick to point out that atoms and molecules tend to be sticky little entities. When a partial tone is an integer multiple of the lowest frequency, it is a harmonic. When the torques are equal, making the net torque zero, no rotation is produced. Opposite
results for opposite situations. The advent of electric motors brought to an end much human and animal toil in many parts of the world. Light consists of transverse waves. (b) Product oxygen atoms pull electrons away from H atoms in H2O molecules and are reduced. Similarly, an iron isotope with 26 protons and 30 neutrons is called iron-56, and one
with only 29 neutrons is iron-55. If this were the case, however, the distribution of galaxies we observe today and their relative motions would be quite different. C H A P T E R 18 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S 465 The pH Scale is a numeric scale used to express the acidity of a
solution. years we will consume more energy than has heretofore been . 67. Fallout results mainly from the fission. Because fluorine is more electronegative than carbon, the dipoles of the exposure of the northern night sky
Long-wavelength reradiated energy is not transmitted out through the glass and is trapped inside. 196 PARTONEPHYSICSFIGURE8.18 (a) Water flows from the reservoir of lower pressure to the reservoir of lower pressure 18.23
is one example. To complete the circuit, these hydroxide ions migrate across the porous electrodes and through an ionic paste of potassium hydroxide, KOH, to join with hydrogen at the hydrogen-facing electrodes and through an ionic paste of potassium hydroxide, KOH, to join with hydrogen at the hydroxide ions migrate across the porous electrodes. His discovery, now called Bernoulli's principle, can be stated as follows: Where the speed of a fluid increases, internal pressure in the fluid
decreases. A confined flame of acetylene burning in oxygen is hot enough to melt iron, which makes acetylene a choice fuel for welding (Figure 19.10). Octane, C8H18 Polyethylene Hydrocarbons also differ in the way the carbon atoms connect to one another. This explains why elements of the same group have similar properties—a concept first
presented in Section 12.4. REVIEW 315 FIGURE 12.31 Two-time Nobel laureate Linus Pauling (1901-1994) was an early proponent of teaching beginning chemistry students a shell model, from which the organization of the periodic table could be described. Pulsar A celestial object (most likely a neutron star) that spins rapidly, sending out short,
precisely timed bursts of electromagnetic radiation. The flotation device and the descending air parcel in this example are both stable, with respect to their environments. The terrestrial planets are rocky and have no rings. (b) A simple model showing convection currents in the asthenosphere. p. Recall from Chapter 1 that velocity is a vector quantity.
(If you've completed this exercise without actually trying it, shame on you!) 85. The East Coast does not benefit from the moderating effects of water because the direction of air is from the land to the Atlantic Ocean. CHECKPOINT Impure water can be purified by which of these? There remains much speculation about how these findings affect the
fate of the universe. Your weight is greater on Earth than on the Moon. CHAPTER 9 9.1 M AG N E T I S M A N D E L E C T R O M AG N E T I C I N D U C T I O N Magnetic Poles EXPLAIN THIS In what sense are magnetic poles similar to the sides of a coin? The flotation device pops right back to the surface. Each fluorine atom achieves a filled
valence shell. X-rays, for example, continue to be used for medical diagnosis despite their potential for causing cancer. The stretching force" called tension. Likewise for chemicals. Streamlines are the smooth paths of bits of fluid. They are not forced to vibrate at a particular frequency; instead, each vibrates at its own
characteristic frequency. (b) A bronze statue turns green. It was fun posing such questions and seeing if we could answer them. On the contrary, writings of the time suggest most Europeans viewed humans as filthy and sinful because of Earth's lowly position— farthest from heaven, with hell at its center. (c) Yes, the time would be the same for the
same height, whatever the launching angle. So Wegener's hypothesis of continental drift was on the right track. THENATURE OFSCIENCE The essence of science is expressed in two questions: How would we know? In a conventional car, braking converts KE to heat. Most are sand-sized grains, which are seen as "falling" or "shooting" stars.
Precipitation Formation Have you ever noticed the long white lines left in the sky after a jet plane passes? In such cases, supermassive amounts of matter are likely falling into central supermassive black holes. Bohr's quantized model of the atom thus became known as the planetary model. (b) When the needle is aligned with the magnetic field, the
forces no longer produce torques. The body, therefore, has a hard time distinguishing between the two and absorbs strontium as though it were calcium. 2 New ton's Second Law of Motion 2. Dwarf planet A relatively large icy body, such as Pluto, that originated within the Kuiper belt. How much greater is the mean distance between Earth and the
Sun compared to the diameter of the Sun? Some molecules are able to stabilize a negative charge by passing it from one atom to the next by a flip-flopping of double bonds. In this case, both plates are composed of buoyant granitic-type rocks. Falling objects pass right through it. What is an ionic crystal? As discussed earlier, homogeneous means that
a sample taken from any part of a mixture is the same as a sample taken from any other part. 2 Ear th's Internal Layers 21. A third source of heat came from the decay of naturally occurring, widely distributed radioactive, is much like the fears of electricity more than a century ago. These
charge carriers are called conduction electrons. A glass tube, longer than 760 mm 76 cm and closed at one end, is filled with mercury and tipped upside down in a dish of mercury. (d) more than four times as much. † For exponential decay we speak about half-life, the time required for a quantity to reduce to half its value. Those galaxies with notable
activity are sometimes called active galaxies. CHAPTER 8 REVIEW 215 R E A D I N E S S A S S U R A N C E T E S T (R AT) If you have a good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. (b) The small charge similarly has more PE when pushed closer to the charged sphere. FYI
CHECKPOINT What law of physics tells you that if a current-carrying wire produces a force on a magnet must produce a force on a currentcarrying wire? No gurgling would occur if you tried this experiment on the Moon where there is no atmosphere. According to the principle of equivalence, the same should apply in an accelerating
spaceship. The circuit shown in Figure 8.30 illustrates the following major characteristics of parallel connections: 1. Whenever one object exerts a force on a second object exerts an equal and opposite force on the first. (a) The fission fragments of a heavy nucleus such as uranium are less massive than the uranium nucleus.
Furthermore, our relatively high daily spin rate allows only a brief and small lowering of temperature on the nighttime side of Earth. If you push a crate horizontally with a force of 100 N across a 10-m factory floor, and the friction force between the crate and the floor is a steady 70 N, how much kinetic energy does the crate gain? Write a letter to
them, without using equations, and explain the difference between velocity and acceleration. The coin is moving along with you when you toss it. 10, 2011 Jun. MasteringPhysics achieves this improvement by providing students with instantaneous feedback specific to their wrong answers, simpler sub-problems upon request when they get stuck, and
partial credit for their method(s). Your friend is correct: Changing the KE requires work, which means more fuel consumption and decreased air quality. The second ball, after rising, falls and also strikes the ground below. Direct Current and Alternating Current Electric current may be direct or alternating. So clocks run slower on the surface
of Earth than they do on the surface of Mercury. We see many cases daily of people who are caught misrepresenting things and who soon thereafter are excused and accepted by their contemporaries. Nimbostratus clouds are dark and foreboding. If the reaction results in the dispersal of energy (an overall increase in entropy), then the answer is yes.
Which minerals crystallize first from cooling magma? This is because the electrons that emit the light are vibrating in many random directions. Is ac or dc required? With a chemical change, reverting to the original conditions does not restore the original appearance. Stable air forced to rise spreads out horizontally, so we see stratus-type clouds:
 cirrostratus, altostratus, nimbostratus, or stratus. So air conditioners must be used to extract heat from the pressurized air. The volume of air has a mass of about 1.25 kg, so 800 m 3*1.25 kg/m 3=1000 kg (about a ton). (a) 0 years (b) 15 years (c) 30 years (d) 60 years (e) 90 years REVIEW 14 C H
A PTER14 Elements of Chemistry 14. The mineral matter glues the particles together and acts as a cementing agent. This is because Earth's atmosphere acts as a lens and refracts light into the shadow region—sufficient light to faintly illuminate the Moon. A black hole is (a) an empty region of space with a huge gravitational field. The third day?
Between successive compressions is a stretched region called a rarefaction. The characteristics of regional metamorphism include (a) folded and faulted rock layers. An airplane is flying horizontally with speed 1000 km/h (280 m/s) when an engine falls off. No life is expected to be found on this moon because of the intensely cold temperatures. We
will explore the outer planets in the order of their distance from the Sun. We can see why warm air rises. Chemistry has influenced our lives in profound ways, and it will continue to do so in the future. For silver, the time would be less than a minute. That's why a breeze is an effective deterrent to mosquito bites. According to the EPA, when coal
power is used to illuminate a single incandescent lamp, more mercury is released into the air than exists in a comparably luminous CFL. So as a restricted body of water dries up, the first minerals to crystallize are those that do not dissolve so easily—those with lower solubilities. Thermonuclear fusion is analogous to ordinary chemical combustion
CAUTION: The mass of this product pulls on every other mass in the universe, with an attracting force that is proportional to the product of the masses and inversely proportional to the square of the distance between them. Hewitt (top) Lillian Lee Hewitt/Paul G. A weather map is essentially a representation of the frontal systems and the high-
pressure and low-pressure systems that overlie the areas outlined in the map. Note that the masses of the nucleons are different when combined in the map. Note that the masses of the nucleons are different when combined in different when
 because of an applied voltage across the circuit. By definition, we are currently in an ice age because continental-scale glaciers are present on Earth. (d) 60 m/s. d, 10. You know that 1 kg of Ping-Pong balls contains more balls than 1 kg of golf balls, as Figure 17.1 illustrates. Like a free-floating balloon, the parcel can expand and contract freely
 without heat transfer to or from air outside the parcel. If for some reason the pressure is reduced or increased on one side only, as in a strong wind, then watch out! Barometers An instrument used for measuring the pressure of the atmosphere is called a barometer. An orbiting planet would keep on orbiting as though nothing happened. (b) Earth
This is an increase in entropy; hence, exothermic reactions are favored to occur. Estimate whether entropy increases or deceases with the following reaction. Many popular brands of bottled water, for example, contain fresh water that has been treated either by distillation or by reverse osmosis. (It does.) Does the cinnamon smell of the charcoal
increase or decrease as it is warmed? If it occurs in 1 s, the frequency is one vibration per second. A shock wave and its resulting sonic boom are swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound, just as a bow wave is swept continuously behind an aircraft that is traveling faster than sound.
hydrogen atoms per liter. Down by the equator (0° latitude), the setting crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the setting crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon, while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat on the horizon while up close to the North Pole (90° latitude), the crescent Moon lies flat 
energy can later be transformed into KE. How many gold atoms are there in a 5.00-g sample of pure gold, Au (197 amu)? This process is radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive, which, because it involves the decay of the atomic nucleus, is often called radioactive decay.
strong base? C H A P T E R 17 H O W CH EM I C A L S R E AC T 443 CHECKPOINT Do all covalent single bonds have the same bond energy? Temperature decreases as one moves up in the troposphere, increases as one moves up in the stratosphere.
mixtures and the way elements combine to form compounds. You may see beauty in a structure such as the Golden Gate Bridge, but you'll see more beauty in that structure when you understand how all the forces that act on it balance. The photo shows physics teacher Marshall Ellenstein walking barefoot on broken glass bottles in his class. The
statement not only is capable of being proven wrong, but has been proven wrong. When our frame of motion has zero acceleration, it is called an inertial frame. Rank from greatest to least the amount of lift on the following airplane wings: (a) area 1000 m2 with atmospheric pressure
Condensation Polymers A condensation polymer is formed when the joining of monomer units is accompanied by the loss of a small molecule, such as water or hydrochloric acid. Figure 1.22 illustrates this. Which model is best can be determined only after the collection of more evidence. For a mixture of iron and sand, take advantage of the fact that
lightest atom, makes up more than 90% of the atoms in the known universe. When I walked toward Burl to borrow one of his brushes, he asked if tensions in the carbon atom and one oxygen atom bonded to another carbon atom. As people
learned more about electricity—understanding both its dangers and benefits—they came to accept this new technology. (c) property of all matter. As a result, the oxygen side of the water molecule is slightly positive, which makes water a sticky sort of molecule. This difference involves a number of factors,
including the strength of the chemical bonds in the solute molecules are packed together. The Ping-Pong balls are the other molecules that make up the bulk of material being cooked. REVIEW 553 79. Igneous Rocks at Earth's Surface Igneous rocks are divided into two general categories based on where they formed. In
the lab part of your course you'll likely learn how to connect these instruments in simple circuits. (b) If both the distance and the force are douF 2F bled, four times as much work is done, which produces four times as much change in kinetic energy. The energy travels through wires to homes, where it is used for lighting, heating, cooking, and
operating electrical gadgets. The long-term costs of not implementing such systems, however, may be even greater. Most fissure eruptions occur underwater as basaltic lava erupts where the ocean floor is spreading apart. See also Minerals deformation of, 540-541 erosion of, 540 formation of, 530-533, 548-549 igneous, 534-539
metamorphic, 534, 545-548 partial melting of, 535 plutonic (intrusive), 539 sedimentary, 533, 539-544 types of, 533-549 rock record, 620-646 angular unconformity and, 623-625 geological features, 533, 539-544 types of, 533-549 rock record, 620-646 angular unconformity and, 623-625 geological features, 534, 545-548 partial melting of, 535-548 partial melting of, 535-548 rock record, 620-646 angular unconformity and, 623-625 geological features, 536-538 weathering of, 535-548 partial melting of, 536-538 weathering of, 536-53
time and, 626-641. The number 0.001 is 10-3, so The number 0.01 is 10-3, so The number 0.01 is 10-2, the logarithm of which is - 2 (the power to which 10 is raised). What color is the red cabbage before being boiled? If the iron is thrown overboard, does the water level at the side of the lock rise, fall, or remain unchanged? No case CHAPTER 8 S TAT I C A N D CU R R E N T E
LECTRICITY of the creation or destruction of net electric charge has ever been found. TUTORIAL: Black Holes was witnessed in 1987. Ultraviolet light from the spreading ocean floors. 1.4 Net Force 10. A study of Earth's oceans leads to a focus
on the interactions between the hydrosphere and atmosphere. 3 5 The energy of sunlight simply and nicely harnessed. That's why the average coal-burning power plant is a far greater source of airborne radioactive material than a nuclear power plant are magnetic fields, and how are changes in them essential for the operation of electric
generators and electric motors? 4 Radiometric Dating 13. A given force exerted on a small mass produces a large acceleration, while the same force exerted on a large mass produces a small acceleration. Why will a volleyball held beneath the surface of water have more buoyant force than if it is floating? The hum is louder if any other mechanical
 parts are set into vibration. This is accomplished with a salt bridge, which may be a U-shaped tube filled with a salt, such as sodium nitrate, NaNO3, and closed with semiporous plugs. The greater the wave Mass Pendulum speed. This light continues on to 2 and, again, because the light is at 45° to the axis of 2
light gets through! 97. Primary and secondary levels of treatment are also not without great cost. These properties make Teflon an ideal coating for cooking surfaces. d, 7. (b) The formation of nitrates is an example of oxidation. * By means such as appropriately designed brushes (contacts that brush against the rotating armature, as shown in the
figures), the ac in the loop(s) can be converted to dc to make a dc generator. Wegener's contemporaries assumed that if the continents were to move, they would have to push through solid rock. These are Pegasus's rear legs, which overlap with the Andromeda constellation. Acids and bases may be defined in several ways. (c) How much impulse acts
on the guardrail? Hydrogen sulfide, H2S, burns in the presence of oxygen, O2, to produce water, H2O, and sulfur dioxide, SO2. asten one end of a Slinky to a wall and hold the free end in your hand. A fast-moving marble slows when it hits slower-moving marbles, he contents of the sewer systems that underlie most municipalities must be treated
before being released into a body of water. State Faraday's law. The notes of a piano keyboard range from 27 Hz to 4200 Hz, but to duplicate the music of a piano keyboard range of the frequencies of an electrical sound system, the closer the musical
output approximates the original sound, hence the wide range of frequencies that can be produced in a high-fidelity sound system. This is where submarines hide. (b) When an electron wave is confined, it is reinforced at only particular frequencies. 284 PA R T O N E P H Y S I CS Sunlight d Vi ol et Re F I G U R E 11. Alcohol An organic molecule that
contains a hydroxyl group bonded to a saturated carbon. Elemental chlorine, Cl2, consists of chlorine molecules. So there is a strong connection between density and elasticity within Earth's interior. If a radioactive isotope has a half-life of 1 day, how much of an original sample is left at the end of the second day? (c) diminished by interference.
Unequal heating of Earth's surface is responsible for weather; this is greatly affected by the presence of oceans but is not completely dependent on oceans. Once the gravitational collapse of a cloud begins, gravity ensures that it continues. CHECKPOINT Explain why you can hold your fingers beside the candle flame without harm, but not above the
flame. Of course, falling on a mat is preferable to falling on a solid floor because the mat also increases the time during which the force acts. m 3.7 (c) If Art's mass is 40 kg, Bart's mass is 40 kg, Bart's mass is 40 kg, Bart's mass is 70 kg, and the height of the initial jump was 4 m, show that Art rises a vertical distance of 7 m. Fundamental frequency of vibration, or the
first harmonic. (b) What is the height of the bridge if the time the rock is airborne is 2 s? In pure water, therefore, the total number of hydroxide ions. Most hydrogen in America is produced from natural gas, in a process that uses high temperatures and pressures to separate hydrogen from
hydrocarbon molecules. FIGURE 18.34 Zinc strips help protect the iron hull of an oil tanker from oxidizing. From Itotal = I1 + I2 + V I3 + p + In, a substitution of I = for each current gives R V V V V V = + + + p + . The changes in physical and chemical conditions to which the rock is exposed can transform the rock. Sand dune A landform created
when airflow is blocked by an obstacle, slowing air speed and therefore promoting the deposition of airborne sand. Imagine that Earth's crust is a cargo ship and that the mantle is the ocean. (a) (b) (c) FIGURE 20.28 Clastic sedimentary rocks. The Sun loses mass as hydrogen nuclei combine to make helium nuclei. Ultraviolet light is not only harmful
to your skin, it is also damaging to tar roofs. H OH Pseudoephedrine hydrochloride (salt) Relative Strengths of Acids and Bases EXPLAIN THIS I CH3 C C 18.2 CH3 FIGURE 18.6 H Cl

Why is hydrogen chloride, HCl, such a strong acid? What is the relationship between work and power? Light things like smoke rose, and heavy things like dropped
boulders fell. If the influence of stars and planets is gravitational, then credit must also be given to the effect of the gravitational pull between the newborn and Earth itself. FIGURE 2.25 INTERACTIVE FIGURE 7.25 INTERACTIVE FIGURE 3.25 INTERACTIVE 5.25 INTERACTIVE 
power, current, and voltage? No; the colors are merely an artificial computer rendering. Plastic deformation typically occurs deep below the surface where temperature and pressure conditions are high; it causes rock to fold and flow. Newton's third law; every action has a reaction. TUTORIAL: Polymers TUTORIAL: Polymers from Monomers FIGURE
19.25 Monomer 
condenses to form liquid water, condensation rate because the evaporation rate is not fast enough to turn the freshly created liquid water back to vapor before more water condenses. Do you see this as a sign of strength in Bertrand Russell? At age 17, he entered the Academy of Plato, where he worked and studied for 20
years until Plato's death. Whether the comet comes from the Kuiper belt or the Oort cloud, it still has the potential for colliding with a planet. New Orleans, Louisiana, and coastal Mississippi were hit particularly hard. The concentration of hydronium ions in any aqueous solution multiplied by the concentration of the hydroxide ions in the solution
H3O+ times the molarity of OH- equals Kw." Writing in scientific notation, we have [H3O+][OH-] = Kw = 1.0*10-14 For pure water, the value of Kw is the concentration of hydroxide ions, 0.0000001 M, which can be written in scientific notation as [1.0*10-7][1.0*10-7] = Kw = 1.0*10-7
10-14 The constant value of Kw is quite important because it means that no matter what is dissolved in the water, the product of the hydronium-ion and hydroxideion concentrations always equals 1.0 * 10-14. (b) h = gt 2/8 = So from y = 12 gt 2, h = g a b = g a b = 2 2 4 8 g(4 \text{ s})2/8 = 2g = 19.6 m. (a) Show that the bus' acceleration is now 67 a. How
do the masses of electrons compare with the masses of protons? The melt is different from the original "rock" because it is richer in H2O (the water plus ice). The focus is showing symbols for concepts, rather than their numerical values. (b) mass. A small proportion of the invisible mass is simply matter that has grown so cold that it doesn't emit
enough light for us to see. Can you see that it doesn't have to fall very far or fast before air resistance builds up to equal its small weight? Because high-silica minerals are the last to crystallize, the magma becomes enriched with silica. With some parts working and others not working, the cell is thrown so far off balance that it dies. Ziplock sandwich
bags are also commonly made of PETE. c. At that moment you pass through the event horizon, which is a mathematical boundary, not a physical one. In addition to stars, however, are the cloudlike nebulae, some of them with a distinct spiral-shaped structure. A common classroom demonstration of resonance is illustrated with a pair of tuning forks
adjusted to the same frequency and spaced a meter or so apart (Figure 10.17). Furthermore, the maximum number of electrons allowed in the first shell is 2, and for the second and third shells it is 8. One domain pole is attracted to the maximum number of electrons allowed in the first shell is 2, and for the second and third shells it is 8. One domain pole is attracted to the maximum number of electrons allowed in the first shell is 2, and for the second and third shells it is 8.
force on Earth. Because an ammeter is connected in series with the circuit it measures, its resistance counts, then the air (reaction), and the apple (action), and the apple (action), and the apple (action), and the apple (action) are not apple (action). In a zone of tensional faulting, the hanging wall drops down relative to the footwall, forming a normal
fault. Call direction to the right positive. The rocks at the center, or core, of a syncline 3 are the youngest, and as you move horizontally away from the 2 axis, the rocks get older and older. What is the source of this blueness? This pushing force, averaged over the wall area, provides the pressure of the enclosed air. As our Sun goes through this final
collapse, the layers of plasma and gas surrounding the core will be ejected in a brilliant display, forming what is called a planetary nebula (Figure 27.13). Reactants The reacting substances in a chemical reaction. The electrons in the rubber sense the same voltage as those in the copper, but their bonding to the fixed atoms prevents the movement of
charge that so freely occurs in the copper. Similarly, a boxer rides or rolls with the punch to reduce the force of impact (Figure 3.6). ... And the second Vertical component does not pass through this second polarizer F I G U R E 11. They appear motionless only because their orbital period coincides with the daily rotation of Earth. The weight at the
surface, therefore, is 100 times as much, as suggested in Figure 27.18. They are realities that chemists have already been demonstrating in the laboratory. Most meteorides, as we discuss later. CHECKPOINT How believable would our present technology be to someone
living 200 years ago? Beta particle An electron emitted during the radioactive decay of a radioactive nucleus. A mines are organic compounds that contain the amine group—a nitrogen atom bonded to one, two, or three saturated carbons. Crystallization is the growth of a solid from a liquid or gas whose atoms come together with a specific chemical
composition and crystalline arrangement. The Formation of Minerals EXPLAIN THIS M Te elt m ing pe ra tu r O M rde elt r o in f g es S Co ilico nt n en t Low High Last High Low First F I G U R E 2 0 .1 3 High-silica-content minerals have low melting points. So, clearly, equal masses of these two particles do not yield equal numbers of carbon atoms
and oxygen molecules. How do composting toilets remove the bad smells of human waste? Does your image rotate also? Why is it inaccurate to say that heavy objects sink and light objects float? Collect all the pennies and add them to the dimes that were heads-up. But Hess, a scientist as well as a sailor, continued using the fathometer in the open sea
to collect data about the deep ocean bottom. S TARSANDGALAXIES 757 FIGURE 27. Students can also take notes in eText using the annotation feature at the top of each page. Acetic acid, however, is a weaker acid because the resulting oxygen ion is less able to accommodate the negative charge. Longitudinal Waves 242 PARTONEP
HYSICS FIGURE 10.6 INTERACTIVE FIGURE (a) Both waves transfer energy from left to right. 3 3 way back to the generators. The force that holds a balloon to the Wall cannot support your heavier head. Thermal energy is carried in the Gulf Stream from tropical waters to the North Atlantic, where it warms the otherwise cold climate. A nanosize
circuit board, for example, might be carved from a larger block of material. To this day, the report is a model of clarity and reason. Radiation The transfer of energy by means of electromagnetic waves. KE = 12 mv2 = 12 (84 kg) (2 m/s)2 = 168 J. Planetary nebula An expanding shell of gas ejected from a low-mass star during the latter stages of its
evolution. A simple rearrangement of Newton's second law gives Fnet = ma. As a result, government agencies, industries, and concerned citizens are involved in extensive efforts Transparent matrix of processed silicon dioxide Chemically disinfected drinking water Caffeine solution Thermoset polymer Prescription medicines stored in refrigerator
Chlorofluorocarbonfree refrigerating fluids E L E M E N T S O F CH E M I S T RY 349 LEARNING OBJECTIVE Define chemistry as a central science that has had a great impact on society. If you throw it down instead, will its acceleration after leaving your hand be greater than 10 m/s2? The alpha particle disappeared. How could it be used indirectly?
CHECKPOINT A uranium atom is 40 times as heavy as a lithium atom, but only slightly larger in size because its more highly charged nucleus pulls harder on its electrons. 63. Why is it important that the mud walls be thick? Science, art, and religion can work very well together, which is why we should never feel forced into choosing one over the
other. An important rule of friction is that it always acts in a direction to oppose motion. When bonded to an atom with low electronegativity, such as any group 1 element, the nonmetal atom pulls the bonding electrons so closely to itself that it forms an ion. In answer to the question "What keeps Earth moving around the Sun?" a friend asserts that
inertia keeps it moving. Sunlight can leave our Sun because the speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the great speed of light is much greater than the escape velocity. A B C CHAPTER 4 60. This plus the greater than the greater 
minerals, 526-527 Climate air motion and, 666-669 atmospheric circulation and, 661-664 solar energy and, 662-666 terrestrial radiation and, 671 seasons and, 662-666 terrestrial radiation and, 661-669 atmospheric circulation and, 662-666 terrestrial radiation and, 663-664 solar energy and, 662-666 terrestrial radiation and, 671 seasons and, 663-664 solar energy and, 662-666 terrestrial radiation and, 671 seasons and, 663-669 atmospheric circulation and, 661-669 atmospheric circulation atmosph
level and, 689-690 low, 690, 691-692 middle, 690, 691 Oort, 731 precipitation formation and, 692-693 Clusters, galactic, 760-762 Coastlines, 656-660 Collisions, 68-70 Colors, 275-282 additive primary, 278 of clouds, 281 complementary, 278-279 dispersion and, 282-284 of minerals, 527 mixing of, 277-278, 279 of rainbows, 282-284 selective
reflection and, 276 selective transmission and, 276-277 of sky, 280 of stars, 741-742 subtractive primary, 279 of sunsets, 280-281 Composite cone volcanoes, 537-538 Compounds, 356-358 covalent, 377 ionic, 372 naming of, 358-358 covalent, 379 ionic, 372 naming of, 358-358 covalent, 370 ionic, 372 naming of, 358-358 covalent, 375 ionic, 372 naming of, 358-358 covalent, 375 ionic, 375 
359 organic. O nly an impulse external to a system can change the momentum of a system. The gills of a fish, therefore, must be highly efficient at extracting molecular oxygen from water. Water vapor, carbon dioxide, and other greenhouse gases in the atmosphere retain heat that would otherwise be radiated from Earth to space. The Leaning Tower
experiment discredited the idea that heavy things fall proportionally faster. Glass is transparent to short-wavelength light and is (a) opaque to light of longer wavelengths. As these clumps form and settle, they carry with them many of the dirt particles and bacteria. Oxidation causes the zinc cup to deteriorate, and eventually the contents leak out. In
this area, more than 300 tornadoes touch down each year. What makes gold so soft (easily scratched) while diamond is so much harder? (a) The net force is zero (because the velocity is constant). When a plant dies, replenishment of carbon-14 stops. LDPE is most useful for such items as plastic bags, photographic film, and electrical-wire insulation.
As can be seen in Figure 15.22, the greater the distance between two atoms in the periodic table, the greater the difference in their electronegativities, and hence the greater the distance between two atoms in the periodic table, the greater the distance between them. In effect, the bug chases part of the waves it has produced. We say that momentum is conserved. Many animals do not have sweat glands
and must cool themselves by other means (Figures 7.22 and 7.23). A nonpolar substance tends to have weak attractions to itself, which causes a low boiling point. GUIDELINE 3 CHECKPOINT What is the systematic name for NaF? Altostratus clouds are gray to blue-gray, and they often cover the sky for hundreds of square kilometers. What do the
outward and inward forces acting on a star have to do with its size? The next time you pick up a galvanized pail, think of Luigi Galvani in his anatomy laboratory. It's just that all of these points are now quite far away from one another. Is this an example of basic or applied research? Positively or negatively? Where adjacent upward-moving convection
cells diverge at the surface, lithospheric plates spread apart. The lower mantle extends from the outer core to a depth of about 700 km (the dashed line in Figure 21.4). All problems nevertheless stress the connections in physics. The moist air upward.
Assume the glass contains about a 1,000,000 million trillion molecules, which is about 30 mL. The original reactor built in 1942 was just "barely" critical because the natural uranium that was used contained less than 1% of the fissionable isotope U-235 (half-life 713 million years). Pluto is an ice body. In the language of chemistry, however, salt is a
material. (b) Show that the ball leaves the table at 6.0 m/s. People who work around radioactivity wear film badges to monitor the amount of radiation. When it comes to celestial bodies, such as planets and stars, why doesn't a larger size necessarily mean a company of the co
larger mass? 4 Classification of RockForming Minerals 20. FIGURE 3.2 When you push with the same force for twice the impulse and religion similar? (c) internal vibrational motion. At this point, outward thermal pressure balances inward gravitational
pressure, and the star's size stabilizes. This compound has even greater antiseptic properties than phenol, and yet it does not damage tissue. So some brain functioning occurs in your eye. That's because radiators do very little heating by radiation. 9.6 Electromagnetic Induction 18. 116 PA R T O N E P H Y S I CS 81. Consider a radioactive sample
 with a half-life of one week. These first four planets—Mercury, Venus, Earth, and Mars—are called the inner planets because of their relatively close proximity to the Sun. LEARNING OBJECTIVE Describe the physical and chemical conditions that give rise to different igneous rocks. This mobility helps accommodate the negative charge, which is why
the phenolic group readily donates a hydrogen ion. Instead, researchers are looking for novel ways of providing fuel cells with hydrogen. Now we turn our attention to how minerals form. If a fusion reaction produces no appreciable radioactive isotopes, why does a hydrogen bomb produce significant radioactive fallout? The chemical equation must
therefore be balanced. (b) frequency. F I G U R E 4 .1 7 Whether launched at an angle upward or downward, the vertical distance of fall beneath the idealized straight-line path is the same for equal times. It's always easy to look back over time and see the progression of events that led to our present state. Inertia The property of things to resist
changes in motion. Differentiate between a cold front and a warm front. The cardinal rule in science is that all hypotheses must be testable—they must be testable—they must be susceptible, at least in principle, to being shown to be wrong. When an ice cube melts, the water level at the side of the glass is unchanged (neglecting temperature effects). The molar mass of any
substance, be it element or compound, is defined as the mass of 1 mole of the substance. This implies a distant past that was much warmer—a situation likely made possible by the greenhouse effect of a thicker atmosphere. The tangential velocity of a planet or moon moving in a circle is at right angles to the force of gravity. Progress in science is
made as scientists conduct research. In contrast, a constant expansion of space after the Big Bang with different regions of the universe. The names of the constellations today carry over mainly from the names assigned to them by
early Greek, Babylonian, and Egyptian astronomers. Most of this waste, however, is contained and not released into the environment. The 29.5-day cycle is relative to the Sun and is due to the motion of the Earth-Moon system as it revolves about the Sun. A fusion age will likely see changes touching every facet of our way of life. Underground storage
 of carbon dioxide is already being employed at the Salah natural gas refinery in Algeria. When we consider the quantity force * distance, we are talking about something entirely different—the concept of energy. Wells once wrote (in The Outline of History), "Human history becomes more and more a race between education and catastrophe." a. '
Nuclear Fusion processes are one of the most misunderstood and controversial areas of science. As air temperature rises, does relative humidity increase, decrease, or stay the same? (b) Show that the ball will reach a height of 45 m (neglecting air resistance).
they land heads-up. The total amount of energy absorbed as these bonds break is + 1370 kJ. John's nephew Graham Orr on page 397 is seen at ages 7 and 21 demonstrating how water is essential for growth. SAM PLE PROBLEM 2 Here is a more conceptual problem. This chapter is about two of the most central concepts in mechanics—momentum
and energy. Furthermore, the Moon possesses a rather small iron core. When you look at a fully formed crystal, what you see is the actual arrangement CHAPTER 20 (a) (b) (c) (d) (e) R O CK S A N D M I N E R A L S 525 (f) FIGURE 20.6 of atoms in its structure. Inland areas are more arid and coastal areas monsoonal. A greater percentage of the
ethanol molecule (about 33%) is made up of the OH bond. Hewitt 74: Paul G. The answer involves molecular motion. Some stars on the celestial sphere are actually much farther away than others from Earth. The air parcel continues to rise until it has cooled enough to match the temperature of the surrounding air. Note that she and her image have
the same color of clothing—evidence that light doesn't change frequency upon reflection. E nergy travels from the Sun through space and then through space and the space and 
(SYNTHESIS) 47. The surface of Earth absorbs this energy, and reradiates part of this as longerwavelength terrestrial radiation. What we do with this tool is up to us. What is condensation, how does it differ from evaporation, and why is it a warming process? Furthermore, without the polar hydroxyl group, the molecular attractions among ether
molecules are relatively weak. The 80-proof vodka is 40% ethanol by volume and 60% water. The debate about whether the universe consisted of one or many islands of stars was settled by the American astronomer Edwin Hubble. Energy indeed is equivalent to mass! General relativity, then, calls for a new geometry not only of curved
space but of curved time as well—a geometry of curved four-dimensional (a) An outside observer sees light travel horizontally in a straight line, but, like the ball in Figure 28.11, it strikes the wall slightly below a point opposite the window. Because most glare we encounter is from horizontal surfaces, the polarization axes of Polaroid sunglasses are
vertical. After the firing, the net momentum, or total momentum, or to
vertically? Blue oceans dominate Earth's surface. What is the purpose of coefficients in a chemical equation? The scales achieved were in the realm of the micron (10-6 m): thus the term microtechnology. Remarkably, the closer the probe gets to the black hole, the slower the clock appears to run. Gravity on the Moon, for example, is much less than it
is on Earth. Universities emerged in Europe in the 13th century, and the introduction of gunpowder changed the social and political structure of Europe in the 14th century. Many pseudoscientists do not recognize their efforts as pseudoscientists.
and there were an infinite number of stars, what effect might this have on the darkness of a clear night sky? CHAP TER 27 10,000 N R Indestructible person standing on a shrinking star S TA R S A N D G A L A X I E S 751 F I G U R E 2 7.1 8 40,000 N 1/2R As the force of gravity increases, so does the escape speed. FIGURE 5.23 The mass of air that
would occupy a bamboo pole that extends to the "top" of the atmosphere is about 1 kg. What happens to the air pressure inside a balloon when the balloon when t
integer multiple of the fundamental frequency. Silver tarnishes because it reacts with the small amounts of smelly hydrogen sulfide, H2S, we put into the air as we digest our food. A few planes are represented in Figure 11.53a. Without the rules of physics, we tend to be superstitious and see magic where there is none. Perhaps it's a fundamental
human characteristic to seek control. VIDEO: Action and Reaction on Different Masses VIDEO: Action and Reaction on Rifle and Bullet 1. The pH of this solution is 10, which is basic. Not so.) CHAPTER 2 1. (b) Explain why middle C (or any other tone) has a longer wavelength in water than in air. If we can't even predict the weather, how can we even
expect to predict the fate of the universe? She pushes an identical block of ice up the ramp. Your friend says that electric current takes the path of least resistance. In Chapter 2 rocket propulsion was explained in terms of Newton's third law. As the air mass moves down the leeward slope, it warms. Add the same amount of crystals to a second still
glass of cold water. At a certain elevation, the bending is abrupt; when the change in medium is gradual (say, from air to water), the bending is gradual, which accounts for mirages. In an electric field, however, an
electron is accelerated whether or not it is already moving. What is happening? A mineral with low solubility does not dissolve easily. What is the evidence for a cloud being composed of particles having a variety of sizes? Only recently have we begun to understand it. The process in which one plate bends and descends beneath the other is called
subduction, and the area where this occurs is called a subduction zone. Assume the speed of sound is 340 m/s. The motion of a fluid in steady flow follows imaginary streamlines, represented by thin lines in Figure 5.36 and in other figures that follow. Other stars form in the same way. The elements in the upper right of the periodic table (except for
the noble gases) have the greatest tendency to behave as oxidizing agents. A lunar eclipse happens only at night when the full Moon passes through Earth's shadow. Po . (b) special kind of force. The control rods are made of a neutron-absorbing material, usually the metal cadmium or boron. Furthermore, reserves of high-quality aluminum oxide ores
are already depleted in the United States. Show that the volume of the displaced air is about 1700 m3. aldehyde 7. Whereas water boils at 100°C, sodium chloride doesn't even melt until 800°C. We say something has a lot of matter if it is heavy. When the test tube is returned to the original temperature, there is no trace of orange ammonium
dichromate. The elevated temperature also helps to minimize the unfavorable decrease in entropy due to the heat absorbed by the reaction. (b) speed. Suppose you exert a 50-N horizontal force on a heavy desk resting motionless on your classroom floor. Here was a phenomenon that acted as the opposite of gravity, possible evidence of Einstein's
once-proposed cosmological constant. The force of wind impact against the sail accelerates the boat. An understanding of how creatures survive at the extremes of temperature can provide clues for practical solutions to the physical challenges faced by humans. 6.5 The Laws of Thermodynamics 16. This vertical motion is detected and translated by a
computer into a topographical image that corresponds to the positions of atoms on the surface (Figure 12.19). LEARNING OBJECTIVE Describe magnetic field strength in terms of domain alignment. Continued cooling by boiling causes ice to form over the surface of the bubbling water. Consider these atoms: helium, He; aluminum, Al; argon, Ar. Rank
them, from smallest to largest, in terms of (a) size, (b) number of protons in the nucleus, and (c) number of electrons. (middle) Shutterstock (right) Joseph Sibilsky/ Alamy (Hg) Shutt
Images (Zn) Eric Schrader/Pearson Science (C) J&L Weber/Photolibrary/Peter Arnold, Inc. A familiar example is an ice skater whose spin rate increases when her extended arms are pulled inward. Which is it: a push or pull, or an interaction? Pioneer 10 passed the orbit of Pluto in 1984. (c) Rank the power output in the secondaries from greatest to
least. Does the battery run down faster if they are connected in series or in parallel? The wave shadow develops between 105° and 140° from the surface location of the earthquake (the epicenter) and has no direct penetration of seismic waves. Oxidation-reduction reactions are responsible for the rusting of a car. On a much smaller life raft, however,
the same 10 passengers would find it necessary to space themselves as evenly apart from each other as possible, lest they tip over. 2 5 F I G U R E 2 7. The lowered potential NASA scientists routinely test various materials for their durability against atomic oxygen, O, which is abundant in the low orbit of the space shuttle. The same is true of voltages
at various locations in an electric circuit. Oil and water do not mix because water molecules are more attracted to themselves than to oil S-16 O D D - N U M B E R E D S O LU T I O N S molecules. Now look at Figure 21.28 in the area of the inactive fracture zone. Magnet - Beta particle electron ($\geq 1$ lectric charge) Radium sample Lead block C H A
PTER13THEATOMICNUCLEUSANDRADIOACTIVITY than harmless helium. The rainfall seen resembles actual rain in that condensation of vapor leads to drops of water. Some of them are shown here. Hypothesis An educated guess; a reasonable explanation of an observation or experimental result that is not fully accepted as
factual until tested over and over again by experiment. What is a galvanometer called when it is calibrated to read current? * Distance fallen from rest: d = average velocity * time d = d = initial velocity + final velocity + f
zero. In a larger piece, more uranium and less surface are presented to the neutrons. This is similar to the way in which small bells ring with higher notes than larger bells. 85 REVIEW 64. Magnetic induction will not occur in nylon, since it has no magnetic domains. So water expands upon freezing. 22. The Quaternary period includes the Pleistocene
and Holocene. In effect, cyan has been subtracted from white light. THINKANDRANK (ANALYSIS) 35. We discussed inertia in terms of objects at rest and objects in motion. If there were air or vapor in the open spaces, the illustration should show molecules there—oxygen and nitrogen for air and H2O for water vapor. 12.3 Protons and
Neutrons 7. The energy in food is expressed in terms of the Calorie, which is 1000 of the calories you'll measure. Why is this resistance greater in a coil with more loops? Let's look at disposable batteries first. Venus takes 243 Earth days to make one revolution around the Sun. Allison exerts a steady net
force of 50 N on a 20-kg shopping cart initially at rest for 2.0 s. Space in our local universe is (a) not empty. H Cl- K+ Cl- Na+ REVIEW C Cl H Cl H Cl C H 65. Scientists in general are comfortable with not knowing. You leap, expecting to easily land on the dock. Hydrocarbon A chemical compound containing only carbon and hydrogen atoms.
Because fewer ions are generated, only a weak current exists, and the bulb is therefore dimmer. It's also a matter of energy output Efficiency = total energy input (More generally, efficiency is useful energy output divided
by total energy input.) Elastic collision A collision in which colliding objects rebound without lasting deformation or the generation of heat. So please don't be troubled about the idea of the inanimate wall pushing on you. At night the ground is often cooler than the surrounding air. Nonetheless, engineers have External pressure Osmotic pressure
FIGURE 16.33 (a) Osmosis results in a greater volume of salt water, which causes the pressure to increase on the salt side of the membrane. CHECKPOINT Because a hot cup of tea loses thermal energy more rapidly than a lukewarm cup of tea.
will? Acetic acid is a weak acid, which means only a few of the acetic acid molecules in solution donate hydrogen ions to form hydronium ions. 14.7 The Advent of Nanotechnology EXPLAIN THIS T Is nanotechnology the result of basic or applied research? You can refer to the table as you study this section, but please do not memorize these bond
energies. To tell the difference between altocumulus clouds and stratocumulus clouds, hold your hand at arm's length and point toward the cloud in question. And what causes magnetism—is it electrical? A good reflector is a poor reflector is a poo
sides of the equation. Just as I can't stand between two adjacent steps, an electron can't exist between two energy levels. Note that temperature does not depend on how much of the substance vou have. So, it was revealed that some of the deepest parts of the ocean are actually near some of the continents, and some of the shallowest waters are in
the middle of the oceans, at the midocean ridges. 3rd harmonic Composite wave Who better appreciates music—one who is knowledgeable about it, or the casual listener? When you can express these concepts in your own words—in your 
order to transform back into a metallic form? Buoyant force that a fluid exerts on an immersed object. Which should weigh more: 100 mL of fresh water or 100 mL of fresh water or 100 mL of fresh sparkling seltzer water? Most substances expand when heated and contract when cooled. F I G U R E 1 9 .1 4 The oxygen in an alcohol, such as ethanol, is
bonded to one carbon atom and one hydrogen atom. Light and sound are both vibrations that propagate Vibrations that propag
appreciable internal source of heat. Place your hands on your legs and straighten your back. Polymers hold a clear promise for the future. Aside from its use in hosiery, nylon also finds important uses in the manufacture of ropes, parachutes, clothing, and carpets. Examples are graphite and diamond. FIGURE 6.8 To the weight watcher, the peanut
contains 10 Calories; to the scientist, it releases 10,000 calories (41,900 J) of energy when burned or digested. We can see this effect in Figure 11.34, where red, green, and blue lights shine on the golf ball. Furthermore, most therapeutic magnets are of the refrigerator type, with a very limited range. In fact, it is about as pure as any water you'll ever
be able to drink. (b) (c) overshoots a circular path and moves away from Earth, against the force of gravity. Draw a conclusion. Perhaps to subsequent Big Bangs? You'll see both the vector nature of momentum and its conservation more clearly when rotational skidding, "English," is not imparted to the cue ball. No new compounds are formed, and so
this is an example of a physical change. What kinds of waves exhibit interference? Conservation of angular momentum is shown in Figure A.11. Frequency and period are inverses of each other. All the many collisions working together keep the balloon inflated. Wastewater effluent from primary treatment, as well as higher levels of treatment, is
commonly disinfected with either chlorine gas or ozone before its release into the environment. The warm air midlatitude cyclones, showing the then cools adiabatically, leading to condensation and precipitation. Phobos orbits in the same easterly direction in which Mars spins (like our Moon), at a distance of only 6000 km in a period of only 7.5
hours. It is quite bright—brighter than all but two stars—and it is second only to Jupiter in mass and size. Does the effect depend on the sign of the charge? Recrystallization A process that occurs when rocks are subjected to high temperatures and pressures and go through a change in minerals; often accompanied by the loss of H2O or CO2. Another
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pendulum swings to and fro at a regular rate of two times per second. This sequence must have been overturned by some structural deformation event, such as mountain building. (A few nearby galaxies, including Andromeda, buck the trend and move toward us.)
and its velocity of recession. If the frequency of a sound is doubled, what change occurs in its speed? Running the cosmic movie backward CHAP TER 27 S TA R S A N D G A L A X I E S 755 F I G U R E 2 7. How could you use the spotlights at a play to make the yellow clothes of the performers suddenly change to black? When the elastic limit is
exceeded, brittle deformation happens in one or two places. This is nuclear fission. An ideal gas is one in which the disturbing effects of the forces between molecules and the finite size of the individual molecules can be neglected. Their chemical structures are shown. Pour a capful of isopropyl alcohol into the egg white and observe what happens.
This is because only in floating does an object displace a weight of the floating object. Over extended periods of time, this causes loss of muscle strength and other detrimental changes in the body. Photograph (b) shows a Ping-Pong ball in sunlight. Instead, they are assigned common names that are more convenient
or have been used traditionally for many years. One of the first to study motion seriously was Aristotle, the most outstanding philosopher-scientist in ancient Greece. Show that the current drawn by the toaster is 8 A. Because it gains electrons in the process, an oxidizing agent is reduced. Land, with a lower specific heat capacity, gets hot in the
summer but cools rapidly in the winter. Adding more lamps in a series circuit produces a greater circuit resistance. Evidence indicates that chlorine atoms are generated in the stratosphere as a by-product of human-made chlorofluorocarbons (CFCs), once widely produced as the cooling fluid of refrigerators and air conditioners. A tiny, though
sloshed back and forth at the appropriate frequency. How many wavelengths? CHAP TER 27 Massive stars must be more luminous than small-mass stars so that the outward pressure of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitational force of their nuclear fusion can offset the greater gravitation fusion can offset the gravitation fusion can offset the gravitation fusion fusion for the gravitation fusion fusi
not be able to hold hot water. When mass m is in grams, using the specific heat capacity of water as 1.0 cal/g # °C gives Q in calories. The temperature of the mixture is ejected from the nozzle. When you stand on two bathroom scales, one
foot on each scale with weight evenly distributed, each scale will read (a) your weight. The power of an electric circuit is given by the formula P = IV . FYI F I G U R E 1 4 .1 8 A schematic of a scanning probe microscope that detects and characterizes the surface atoms of a material by way of an ultrathin probe tip attached to a miniature cantilever. A
ball is tossed off the edge of a cliff with the same speed but at different angles as shown. So long as you touch nothing else of different potential, you CHAPTER 8 TA B L E 8. The name of the element farther to the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right, with the suffix -ide added to the name of the left in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the name of the element farther to the right in the periodic table is followed by the nam
GUIDELINE 1 NaCl Li2O CaF2 Hydrogen has been touted FYI as the fuel of the future. Isotopes Members of a set of atoms of the same element whose nuclei contain the same element whose nuclei contain the same element whose nuclei contain the same number of protons but different numbers of neutrons. Einstein himself often told his friends, "Don't try. Consider hitting a baseball with a bat. (Electrons don't actually spin like
a rotating planet, but behave as if they were—the concept of spin is a quantum effect.) FYI Most of the iron objects around you are magnetized to some degree. A spider hangs by a strand of silk at an eye level 30 cm in front of a plane mirror. LEARNING OBJECTIVE Describe the production of bow waves and shock waves. Spacetime near a star is
curved in a way similar to the surface of a rubber sheet when a heavy ball rests on it. Jupiter's average diameter is about 11 times Earth's, which means Jupiter's volume is more than 1000 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's volume is more than 1000 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 12 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 11 times Earth's, which means Jupiter's average diameter is about 12 times Earth's average diameter is about 12 times Earth's average diameter is about 13 times Earth's average diameter is about 14 times Earth's average diameter is average d
example of a metal produced primarily by electrolysis? Adiabatic A term that describes temperature change in the absence of heat transfer; expanding air cools and compressing air warms. When ice water freezes to become solid ice, its volume increases tremendously. What was the cause of the perturbations discovered in the orbit of the planet
Uranus? Heat of vaporization The amount of energy needed to change a unit mass of any substance from liquid to gas (and vice versa). Vanilla extract, butter, and maple syrup, all natural products, are mixtures. FYI (in the Northern Hemisphere) around the eye. Compared with the heavier bowling ball, the lighter billiard ball has (a) less momentum
and less kinetic energy. You can visualize a plate being pulled into the asthenosphere as being pulled into the support force when water of weight wis poured into the jug? working with her nephew, Otto FIGURE 13.21
INTERACTIVE FIGURE Frisch, also a physicist, published a paper in which the term nuclear fission was first coined. Explain what is happening inside the attracted paper clip. Look at a globe and notice the high latitude of Europe. Why do electrons repel one another? P L U G A N D C H U G (F O R M U L A FA M I L I A R I Z AT I O N) Momentum g
mv 35. See also Phase changes boiling of, 176-177 buoyancy in, 123 evaporation of, 174 freezing of, 178-179 pressure in, 121-123 Lithium batteries, 474-475 Lithosphere, 559-560 Local Group, 760 Local Group, 760 Local Group, 78-79
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poles, 217 Magnetic resonance imaging (MRI), 225 Magnetic therapy, 207 Magnetism, 216-237 electric currents and, 220-222 Mantle, 559-560 Maps, weather, 702 Marble, 548 Mars, 710, 717-718 Mass, 17 actions and reactions on, 49-50 atomic, 299-300 density and, 120 formula, 431-432 of neutrons, 338-339, 341 of protons, 338-339, 341
relative, 431 volume and, 18 Mass-energy equivalence, 338-340 Mathematics, 2-3 Matter classification of, 399-401 pure vs. Why does breathing a mixture of helium and oxygen rather than air help divers avoid getting the bends? Planets Uranus and Neptune would both be about the size of Ping-Pong balls located 2 and 3 km away, respectively
Slowly turn yourself around, keeping the ball in front of you as you move. For you to see a rainbow, the Sun must shine on drops of water in a cloud or in falling rain. (It is interesting to listen, with an amplified stethoscope, to the clicketyclack of domains aligning in a piece of iron when a strong magnet approaches.) The domains align themselves
much as electric charges in a piece of paper align themselves (become polarized) in the presence of a charged rod. Like H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H O C C H H 
increase in heat flow to rift zone areas, resulting in accelerated seafloor spreading, can cause sea level to rise. Rotate a pair of mirrors, keeping them at right angles to each other. When can thermal energy in a system move from lower to higher temperatures? PE = (10 \text{ kg})(10 \text{ N/kg})(5 \text{ m}) = 500 \text{ J}. Two inner shells of electrons shield the valence
electron from the nucleus. More-massive stars have shorter lives than less-massive stars. When the air. New Zealander Jennie McKelvie showing interference with a classroom ripple tank. All the inner planets are solid rocky planets. After combustion, however, the
 electrons are shared between the oxygen and hydrogen atoms in a water molecule and are pulled to the oxygen. And if you do so during a solar eclipse, you'll marvel at the clear crescents on your viewing screen. When gas molecules near the surface of a liquid are attracted to the liquid, they strike the surface with increased kinetic energy and
become part of the liquid. Betelgeuse, on the other hand, appears red because of its cooler surface temperature (about 3400 K). I remember Burl asking me about the tensions in the ropes that held up the scaffold we were on. (b) brightness of reflected light. The elements needed to make these crystals inside the magma, therefore, come from one unit
of MgO, plus one unit of FeO, plus one unit of FeO, plus one unit of SiO2. Can you see why the shadow cast by the red light appears cyan? WAV E S A N D S O U N D 253 TUTORIAL: The Doppler Effect Was this your answer? In the circuit shown, how do the brightnesses of the three identical lightbulbs compare? If there were no air resistance there
 would be no terminal speed at all. Unless stated otherwise, all speeds discussed in this book are relative to the surface of Earth. If you exert a horizontal force of 200 N to slide a desk across an office floor at a constant velocity, how much friction does the floor exert on the desk? (Because of friction, the ball may roll along the wagon surface; without
friction, the surface would slide beneath the ball.) 97. The result is the oxidation of iron atoms and the reduction of copper ions. In what region of the electromagnetic spectrum is the resonant frequency of electrons in glass? How will two dangling vertical sheets of paper move when you blow between them? In this chapter, we will consider the inertia
of moving objects. 292 PARTONEPHYSICS 100. The oxygen our bodies are designed to breathe is gaseous molecular oxygen, O2. To attain a sustained flow of charge in a conductor, some arrangement must be provided to maintain a difference in potential while charge flows from one end to the other. Discuss the advisability of simply removing
the sail in the preceding two questions. But as we opened our eyes and minds to the natural universe, we learned that some speculations were moving at a constant velocity (zero acceleration), the balls would remain suspended in the spaceship were moving at a constant velocity (zero acceleration).
moving by the same amount. 576 PARTTHREEEARTHSCIENCE footwall Hanging wall Footwall Hanging wall Footwall Hanging wall were commonly used by miners because one could hang a lamp on a hanging wall Footwall FIGURE 21.32 The terms footwall. Kinetic energy
mv2 2 Kuiper belt (pronounced "KI-pur") The disk-shaped region of the sky beyond Neptune populated by many icy bodies and a source of short-period comets. This is particularly evident in heavily industrialized regions. (c) Low clouds: stratus, st
of fluid flow in the molten outer core of Earth. Until that happens, we are left with yet another fascinating mystery of our universe. How he would have loved to experiment with today's air tracks! Consider the air track in Figure 3.14. H O CH2CH2CH2 O H 1,4-Butanediol 51. So the tangential speed will be directly proportional to r when all parts
of a system simultaneously have the same v, as for a wheel, disk, or rigid wand. As osmotic pressure FIGURE 16.32 INTERACTIVE FIGURE builds, the rate at which water increases. Was this your answer? Although most transform plate boundaries are short and located within the
ocean basins, a few are quite long, such as the San Andreas Fault in California (Figure 21.29). Would it be slightly more difficult to draw soda through a straw at sea level or on top of a very high mountain? As particles of precipitation grow larger and heavier within a cloud, they begin to fall as rain, which drags some of the cool air along with it to
create a downdraft. Note that a magnetic field does not induce voltage: a change in the field over some time interval does. 100 PA R T O N E P H Y S I CS FIGURING PHYSICAL SCIENCE equations, is extraneous information (as would be the color of the ball). What causes electric shock in the body—current or voltage? O OH OH Salicylic acid (a)
Carboxyl group O OH O O Ester Aspirin (acetylsalicylic acid) (b) aldehydes, many simple esters have notable fragrances and are often used as flavorings. If this enclosed field is somehow changed, then in accord with the law of electromagnetic induction, a pulse of current is produced in the loop. (b) How does this equation tell you whether or not your
gravitational acceleration depends on your mass? Enormous work would be required. The "typical" midlatitude cyclone progresses through six distinct steps, starting with cyclogenesis—the birth of the cyclone (Figure 25.15). To release it from water or other chemicals costs more energy than you get back when you burn it. This pulling away does not,
 however, affect the covalent bonds within each sucrose molecule, which is why each dissolved sucrose molecule remains intact as a single molecule. The transformation of benzaldehyde to benzoic acid is an oxidation. When you face a rainbow, the Sun is behind you, in the opposite part of the sky. A moving skateboard because it has speed, or velocity.
Neptune contains greater amounts of methane and ammonia. A red ball of mass m and a blue ball of
Polypropylene (PP) Polystyrene (PS) H H C C H 4 PP H Polyvinyl chloride (PVC) 2 Cl Shower curtains, tubing 3 V (continued) 508 PA R T T W O TA B L E 1 9. Collect the remaining coins. 1 Aristotle on Motion 1. How does
the energy of a protostar differ from the energy that powers a star? Fission occurs mainly for the rare isotope U-235, which makes up only 0.7% of the uranium in naturally occurring uranium metal. Why is a secondary rainbow dimmer than a primary bow? Use g = 10 m/s2 and show that the maximum speed of the horizontally moving ball clearing the
net is about 27 m/s (about 60 mi/h). If a pair of carbon nuclei were fused and the product emitted a beta particle, what element would be produced? What is light? 296 PA R T T W O CH E M I S T RY FIGURE 12.3 As close as Tracy and Ian are in this photograph, none of their atoms meet. Likewise, low-energy exhaust molecules coming out of a car's
tailpipe will not spontaneously come back together to form higher-energy gasoline molecules. So gravity is the cause of the spherical shapes of planets and other celestial bodies. Cell-like circulation patterns set up by atmospheric temperature and global
winds. For our discussion of metallic bonds, we'll focus only on the valence electrons of metal atoms and not on their electron-dot structures. If we look straight down into water, an object submerged 4 meters beneath the surface appears to be only 3 meters deep. However, this powerful space telescope and its many successors will, no doubt, also
raise more questions than they answer. What are the atomic number and the atomic number atomic number and the atomic number and the atomic number atomic
enough to hold relatively small quantities of oxygen dissolved in Figure 15.36. 41 ... Few things stick to Teflon because of the high proportion of fluorine atoms that it contains. Search the sky for passing jets and look for the condensation trail—contrail—that the jet leaves behind. (a) A baby's are older because this is surely a trick
question. Evaporation would not cool the remaining liquid because the energy of exiting molecules would be no different from the energy of molecules left behind. 2 T H E F O U R MA JO R C L O U D G R O U P S 1. This nebula is located 5400 light-years from Earth in the constellation Sagittarius. Elemental formula A notation that uses the atomic
symbol and (sometimes) a numerical subscript to denote how many atoms are bonded in one unit of an element. Three pucks, A, B, and C, are sliding across ice at the given speeds. Ozone is more advantageous in that it kills both bacteria and viruses. A B C 74. Each iron atom, then, is a tiny magnet. (a) gold: fission; carbon: fusion (b) gold: fusion;
carbon: fission (c) gold: fission; carbon: fission (d) gold: fission; fission (d) gold: fission; fission; fission (d) gold: fission; fission; fission (d) gold: fission; fission; fission; fission; fission (d) gold: fission; 
through the wire to the container on the right. Are the wavelengths of radio and television signals longer or shorter than waves detectable by the human eye? Energy is the product of force and distance. A chemical bond is the force of attraction between two atoms that holds them together. Adams sent a letter to the Greenwich Observatory in
England; at about the same time, Leverrier sent a letter to the Berlin Observatory in Germany. On most trips, the instantaneous speed is often difference, any charges in the medium move between these locations. As an analogy, consider a pair of magnets. They slide
equal distances of 6 m to meet at the midpoint. For example, water owes many of its properties to hydrogen bonds. Later in its orbit the satellite's potential energy is 6000 MJ. He accepts the idea that the balloon contains micropores but insists that he is simply smelling cinnamon-flavored air. There is a second effect, an extension of Faraday's law.
How does the direction of polarization of light compare with the direction of vibration of the electrons that produced it? They are told that magnets have powerful effects on the body, mainly increasing blood flow to injured areas. The oldest rocks on Earth are the Acasta gneisses, dated at 4.03 billion years old. Energy is nature's way of keeping score.
tars are born from clouds of interstellar dust with roughly the same chemical composition as the Sun (see Chapter 26). Why are the days on Mercury very hot and the nights very cold? Evaporation is the change of phase from liquid to gas. Then dissolve salt in the water until the egg floats. Please explain how this occurs. The chromosphere is the
pinkish layer above the photosphere and below the vast corona. The formation of ice is a physical change, whereas the formation of rust is a chemical change and the negative ion comes from the acid. Hewitt 357: (left)
 Richard Megna/ Fundamental Photographs, NYC 357: (middle) Pearson Education/PH College 357: (middle right) Pearson Education/PH College 357: (middle right) Pearson Education/PH College 357: (middle) Pearson Education/PH College 357: (middle
Satellite A projectile or small celestial body that orbits a larger celestial body. It is interesting to see that succes 7 sive increments of distance increase as a sequence of odd numbers. In what sense can a transformer be thought of as an electrical lever? Faults are not smooth planes—they have irregular surfaces that can interlock and resist movement.
Mohorovic i c's seismographic data had literally drawn a map of the upper boundary of Earth's mantle, a layer of denser rock underlying the less-dense crust. FIGURE 4.34 (a) The parabolic path of steady growth. Hence, 1 g/cm3 = 1000
kg/m3. TUTORIAL: Color VIDEO: Colored Shadows VIDEO: Why the Sky is Blue and Sunsets are Red F I G U R E 11. If the initial universe remained hotter for a longer time, then more hydrogen would be greater. The changes
that occur as we age involve the chemical reformation of our biomolecules, so they are chemical changes. Some minerals have distinctive growth patterns. Burl and I used exaggeration to bolster our reasoning (just as physicists do). Such changes in temperature, caused by changes in pressure, are described by the ideal gas law:** Pressure & density
* temperature D R I V I N G F O R CE S O F W E AT H E R -15° 4 km -5° 3 km 5° 2 km 15° 1 km 687 Ground 25°C in m ar W Assuming relatively small changes in air density, which is generally the case in the lower atmosphere, the ideal gas law states that temperature goes down F I G U R E 2 5 . In standard units and in scientific notation:* F = G Just
as p relates circumference and diameter for circles, G relates gravitational force with mass and distance. What happens to the corrosive properties of an acid and a base after they neutralize each other? Other Polaroid sheets consist of certain aligned molecules rather than tiny crystals. This is because the reduced atmospheric pressure is less
effective in pushing soda up into the straw. Place a jar of water on a small stand on the bottom of a saucepan full of water. Uranus is a cold place. In other words, changes that result in to an increase in are favored. Why would a
balloon that was positively charged also attract the stream of water? Rank these rock-forming minerals from most abundant to least abundan
hard and rigid rock layers become crumpled and folded? Whereas conventional trains vibrate as they ride on rails at high speeds, maglevs can travel vibrationfree at high speeds because they make no physical contact with the guideway they float above. We can put it another way: Shoot a projectile skyward at some angle and pretend there is no
gravity. The cannonball coasts center in circular orbit. Every body in the universe attracts every other body with a force that, for two bodies, is directly proportional to the product of their masses and inversely proportional to the product of their masses and inversely proportional to the square of the distance separating them: m1m2 F = G 2 d 5. Virtually all geologic processes can be traced back to plate
tectonics, although sometimes the link is indirect. 360: (top right) Mondolithic Studio 360: (bottom left) IBM Corporate Archives 360: (bottom right) Dr. Georg Fritz/Team Nanotec GmbH 361: European Communities, 1995–2006 363: (top) Paul G. Object 2003 EL61 has two moons. What type of galaxy is the Milky Way? Hewitt 250: Norman
Synnestvedt/Paul G. (d) Electronegativity does not affect the atom's ability to become oxidized. The mixture is boiled in the flask on the left. Recall the equilibrium. Although Earth's upper mantle is of a similar composition, it is
 divided into two distinct units. How does the astronaut's weight differ from that on Earth? (a) Al3Cl (b) AlCl3 (c) Al3Cl3 (d) AlCl 3. Mercury is very close to the Sun and rotates slowly on its axis. Iron is a material that can be used to build cars. If the beverage contained a significant amount of ethanol, the powder burned, thus providing "proof" of the
beverage's worth. 9 Metamorphic Rocks 20. (For simplicity, only a small portion of the ion array is shown here. After his death, his voluminous notebooks were preserved in caves near his home and were later sold to the library at Alexandria. Those at the upper right tend to gain electrons, and those at the lower left tend to lose them. (b) When the
 object is close to a concave mirror (a mirror that curves inward like a "cave"), the virtual image is larger and farther away than the object. For example, atoms of the first group, which include hydrogen, lithium, and sodium Magnesium
 Aluminum Silicon Phosphorus Sulfur Chlorine Argon Thirdperiod elements C H A P T E R 12 each have a single outer-shell electron. F Na K I K Na F FIGURE 15.8 I K + I - Na+ F Potassium iodide, KI, is added in minute quantities to commercial salt because the iodide ion, I-
it contains is an essential dietary mineral. You must try this experiment to appreciate it. The galaxy appears huge, covering an area six times that of the full Moon. What this means is that anyone anywhere on Earth inhaling a breath of air takes in numerous atoms that were once part of you. When two such monomers come together to form a
condensation polymer, one functional group of the first monomer links with one functional group of the other monomer. EXPLAIN THIS Why do the atoms of group 18 resist forming chemical bonds? At night, the direction of airflow is reversed, because now the water is warmer than the land. A different scaffold that weighs 400 N supports two
painters, one 500 N and the other 400 N. Likewise, green is transmitted where magenta is absorbed. (c) The amplitude is the distance from the equilibrium position to maximum displacement, one-half the 20-cm peak-to-peak distance from the equilibrium position to maximum displacement, and it finally rejoins its original
path with the same speed it had initially (Figure 4.33). For information regarding permissions, call (847) 486-2635. Crystal form The outward expression of the orderly internal arrangement of atoms in a crystal. In the next chapter, we'll see how bits of iron similarly align with magnetic fields. If you shake a rope either up and down or from side to side
as shown in Figure 11.51, you produce a transverse wave along the rope. (d) heterogeneous mixture because it consists of different types of molecules. These two subsets are the inner transition metals. For example, the area of the Pacific Rim is a zone of great seismic activity, as is the area of the Mid-Atlantic Ridge, he outer planets—Jupiter, Saturn,
create a static charge on a rubber balloon by rubbing it across your hair. 16-27 Dec. FIGURE 19.31 The fluorine atoms in polytetrafluoroethylene tend not to experience molecular attractions, which is why this addition polymer is used as a nonstick coating and lubricant. F I G U R E 2 .1 2 A stroboscopic study of a golf ball (left) and a Styrofoam ball
(right) falling in air. 5 Voltage Sources 8. See also Rock record Cambrian period, 630-631 Carboniferous period, 630-637 Devonian period, 631-632 Permian period, 633-634 Precambrian time, 626, 627-630 Silurian period, 631-632
Geosphere, 521. See Radiant energy; Radiation solar, 662-666 sources of, 80-81 Energy-mass equivalence, 338-340 Entropy, 151, 446-447 Equations, chemical, 428-429 Equilibrium rule, 21 Eris, 710 Erosion, 540, 604-605 coastal, 656-657 by glaciers, 611-612 Erosional environments, 605 Erosional landforms, 611-612 Escape
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46 Forecasting, weather, 701-703 Formula(s) chemical, 356-357 elemental, 356 Formula mass, 431-432 Fossil fuels, 544, 633 Fossils, 543-544 Fourier analysis, 257 Fractures, of minerals, 527 Free fall, acceleration of, 28-30, 42-44 Freezing, 178-179 Frequency, 239 Friction, 23-24 Frontal lifting, 695-697 Fuel, 80-81 fossil, 544, 633 Fossils, 544, 633 Fossils, 547-548 Fourier analysis, 257 Free fall, acceleration of, 28-30, 42-44 Freezing, 178-179 Frequency, 239 Friction, 23-24 Frontal lifting, 695-697 Fuel, 80-81 fossil, 544, 633 Fossils, 547-548 Fourier analysis, 257 Free fall, acceleration of, 28-30, 42-44 Freezing, 178-179 Frequency, 239 Friction, 23-24 Frontal lifting, 695-697 Fuel, 80-81 fossil, 544, 633 Fossils, 547-548 Fourier analysis, 257 Free fall, acceleration of, 28-30, 42-44 Freezing, 178-179 Frequency, 239 Friction, 23-24 Frontal lifting, 695-697 Fuel, 80-81 fossil, 544, 633 Fossils, 547-548 Fourier analysis, 257 Free fall, acceleration of, 28-30, 42-44 Freezing, 178-179 Frequency, 239 Friction, 23-24 Frontal lifting, 695-697 Frontal lifting, 
633 Fuel cells, 476-477 Fulcrums, 78 Full Moon, 724 Functional groups, 496-497 Fundamental frequency, 255 Fuses, safety, 205-206 Fusion, heat of, 179 F Facts, 3 Faraday's law, 226-227 Maxwell's counterpart to, 230 Faults, 575-577 Faunal succession, rock dating and, 622-623 Field induction, 230-231 Fields electric, 191-193, 230-231
magnetic, 218-222, 230-231 First law of thermodynamics, 149-150 Fission. Primary Secondary 83. Nanotechnology, however, is still in its infancy, and it will likely be decades before its potential is fully realized (Figure 14.17). In effect, the scale shows the support force. What happens to the temperature of air when it expands? Convectional Lifting
Earth's surface is heated unequally. One million trillion of these are molecules of some poison, while 999,999 million trillion of these are water molecules. As they grow, they shade the ground beneath from the Sun. The order of the Earth science chapters has been reorganized so that Plate Tectonics now follows Rocks and Minerals. Newton's second
law tells us that Solution: a = First, we must convert the units: F = 30 \ g m Rearrange the equation and get Mass = 90 \ N force = 9 \ kg acceleration due to gravity 10 \ m/s^2 Relative humidity = 1 \ m^3 = 7.2 \ m^3 1.25 kg = LEARNING OBJECTIVE Describe the relationships among the three variables that control the weather. Eventually the researchers
traced the source to underwater volcanoes whose rising columns of bubbles resonated like organ pipes. (Ignore air resistance.) 78. And as we know, liquid water changes to a solid—it freezes—at 0°C. Because the corona is not very dense, its brightness is not as intense as the Sun's surface, which makes the corona safe to observe during (and only
during) a total solar eclipse. This initiates the reduction-oxidation reaction between the sulfur and the potassium chlorate, which in turn ignites the burning of the matchstick. Here on Earth fuel-cell researchers are developing fuel cells for buses, automobiles, and trains. The apple is outside the system. You are at the front of a floating canoe near a
dock. As the magma rises, reservoirs of basaltic magma form in the crust. CHAPTER 1 Free-fall distance from rest: d g 1 2 gt 2 REVIEW 33 39. Figure 18.1 shows only a few of the acids we commonly encounter. Its temperature cools, and 325 kg of olivine crystallize from it. Nevertheless, these de1 increments suggested the idea of a lowest
temperature: - 273°C. Explain this in terms of the refraction of all the sunsets and sunrises around the world. The single greedy kid ends up being slightly negative, while the two more generous kids are slightly positive (deficient of electrons). Natural recharge areas are always higher than confined portions of the aquifer, so some water is under
pressure and can flow out of any opening in the aquifer. The wind would have no speed relative to the boat and the sail would simply sag. The leaves absorb rather than reflect red light, so the leaves become warmer. What do you think dark matter might be made of? The chemical equation, however, can provide some important clues. The forces
between planets A and B are equal in magnitude and oppositely directed in each case. From P = A A density g * A * h = B and pulling. For g = 10 m/s2, this becomes g = 10 m/s2.
four covalent bonds of methane. The changing magnetic field of the moving tape induces a voltage in the coil. Figure 11.18 shows how a light wave bends in a similar way. The more washing soda you add, the more carbonic acid you'll need to neutralize it. When Acceleration of Fall Is Less Than g—Non-Free Fall Most often, air resistance is not
negligible for falling objects. Is cleavage the same thing as crystal form? Common sense is relative to one's time and place. What causes comet tails to point away from the Sun? Why does the kinetic energy and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit? 516 PA R T T W O CH E M I S T RY 51. LEARNING OBJECTIVE Spell out the difficulty and momentum of a satellite change in an elliptical orbit.
involved in distinguishing between physical and chemical properties. The international system of choice uses the following units: for mass, the kilogram; for distance, the meter; and for time, the second. In fact, the tree gets mass (carbon, oxygen, and hydrogen) directly from the air, not from the water and nutrients it absorbs through its roots. A
current of charges, then, also produces a magnetic field. LEARNING OBJECTIVE Recognize that all chemical reactions are driven by the tendency of energy to disperse. When you stand facing the wall, you are carried along at the same speed, so you don't notice it. Why is the tennis ball difficult to catch? The antiknock performance of a particular
gasoline is compared with that of various mixtures of isooctane and heptane, and an octane rating is assigned. Note how the tail always extends away from the Sun. Shiny flakes of muscovite are used in glittering body paints, and they add shimmer to auto body paints as well. Things around us approach a common temperature only because good
 absorbers are, by their nature, also good emitters. What is this fundamental rule? This makes high tides not as low tides not
Arts Photo Library/Alamy 245: (bottom left) Laura Pike & Steve Eggen 245: (bottom right) Leslie A. An electron has to be moving across lines of magnetic field in order to feel a magnetic force. Groundwater flow into a stream channel can provide a base flow. Carbonates can form in two ways—by inorganic precipitation and, as we will see later in this
chapter, as a result of biologic activity. This can be demonstrated by filling a garden hose with water and holding the two ends upright. When a source of voltage sets them moving, we have an electric current. O HO C O HO C O HO C O Why then is sulfuric acid so much stronger an acid than carbonic acid? Both statements are true. 240 PA R T O N E
PHYSICS The frequency of a wave FYI matches the frequency of its vibrating source. The type of convergence—or "slow collision"—that takes place depends on the type of lithosphere that is involved. The shadow of the blue lamp is illuminated by the yellow lamp, and thus it appears yellow. See Compounds Chemical elements, 296-297 Chemical
formulas, 356-357 Chemical properties, 353 Chemical properties by mass and, 430-432 endothermic, 441-444 grams-moles conversion atoms and molecules by mass and, 430-445 energy changes in, 441-446 energy changes in, 439-441 counting atoms and molecules by mass and, 430-432 endothermic, 441-446 energy changes in, 439-441 counting atoms and molecules by mass and molecules by molecules b
for, 432-435 half, 470 law of mass conservation and, 428-429 neutralization, 458-459 oxidation-reducts of, 428 rates of, 435-439 reactants in, 428 Chemical sedimentary rock, 543 Chemical
Where is the Sun located when you view a full Moon? He held this post for 28 years. Why does it form? This increase in speed can produce a tornado, which is a funnel-shaped cloud that extends downward from a large cumulonimbus cloud. Conceptual model A representation of a system that helps us predict how the system behaves. 14. Constructing
a fission bomb is a formidable task. Several steps need to happen before precipitation forms. Doppler effect The change in frequency of wave motion resulting from motion of the sender or the receiver. You might hide yourself in the hills, eat the most natural foods, practice obsessive hygiene, and still die from cancer caused by the radioactivity
emanating from your own body. A slightly higher Earth temperature means slightly warmer oceans, which means changes in weather and storm patterns. So why don't atoms simply pass through one another? D 61. This question was posed by the French physicist Louis de Broglie (1892-1987) while he was still a graduate student in 1924. If two
objects of the same size fall through air at different speeds, which encounters the greater air resistance? Left eye Right eye 60° 36. The less-dense warmer air rides up and over the colder, denser air, resulting in widespread cloudiness and light to moderate precipitation that can cover great areas. The "empty" space in an unopened C H A P T E R 16
MIX TURES 409 Carbon dioxide, CO2 soft drink bottle, for example, is crammed with carbon dioxide molecules in the gaseous phase. If the top of the cloud cools as the bottom warms, the cloud becomes unstable to the point that small convection currents develop within the cloud. So we should not be surprised that the name of Einstein, like that of
Jesus or of any other highly respected person, is cited often by charlatans who wish to bring respect to themselves and their points of view. A satellite must remain above Earth's atmosphere because air resistance would not only slow it down but also incinerate it at its high speed. Think of the ocean floor's topography—the highest elevations are at
the mid-ocean ridges. Anticline An up-fold in rock with relatively old rocks at the fold core; rock age decreases with horizontal distance from the fold core. (An exception occurs in flash photography when pupils appear pink, which occurs when very bright light is reflected off the eye's pink inner surface and back through the pupil.) Look at the open
ends of pipes in a stack; the holes appear black. You dip your finger at a steady rate into a puddle of water to make waves. b, c, a. Which materials migrate upward? A skipper on a boat notices wave crests passing his anchor chain every 5 s. He concluded from accumulated observations of eclipses of Jupiter's moon at different times of the year that
light must travel at a finite speed and needed 1300 s to cross the diameter of Earth's orbit around the Sun. The time t is the same time for the ball to fall (y - 0.1y) = 0.9y (due to the height of O D D - N U M B E R E D S O LU T I O N S the coffee can).
dropped from rest and had been falling for the same amount of time. (Try it and see!) 73. Electromagnetic wave emitted by vibrating electric charges (often electrons) and composed of oscillating electric and magnetic fields that regenerate each other. When the water boils, remove the pot from its heat source. Because of the
pressure, melting cannot occur and the inner core stays solid. Water vapor in the air increases this speed slightly. So, reducing soot emissions can be very helpful in slowing the trend toward global warming. The two forces are the normal force and mg, which are equal when the elevator doesn't accelerate and unequal when the elevator accelerates.
8.8 Ohm's Law 22. Discuss why the mass of block B is 20 kg. For the force to be 1 N, the masses at 1 m apart would have to be nearly 123,000 kg each! Gravitational forces between ordinary objects are exceedingly small, and differences in electrical forces between ordinary objects are exceedingly huge. What is a heteroatom? As long as they pull
with equal forces tral boron atom. When illuminated with blue light, it is blue. If we cover the top of the bottle and shake vigorously, the gases separate from the soda and form bubbles. How a color appears depends on the light source (Figure 11.30). Recall (from Section 7.7) that a phase change occurs 10 when water is heated to the boiling point.
16.4 Solubility 11. Henry Heavyweight weighs 1200 N and stands on a pair of bathroom scales so that one scale reads twice as much as the other. Superheated subterranean water can escape violently to form geysers or more gently to form a soothing natural hot spring. Tossed at more than 42.5 km/s (d), it escapes the solar system. Gamma radiation
results in no change in either the mass number or the atomic number. Although scientific methods can be used to debunk various paranormal claims, they have no way of accounting for testimonies involving the supernatural. Pull the paper horizontally with a quick snap. * We'll see in Appendix A that another condition for mechanical equilibrium is
that the net torque equals zero. The following are some important facts about atoms: 1. This 12-degree scale uses observation of damage to estimate an earthquake's strength. Try it now. These ceramic materials are "high-temperature" superconductors. When you jump upward, your hang time is the time your feet are off the ground. Check the
printed data at the base of a CFL to find out. The Andes Mountains of western South America formed in this way. Water treatment requirements are therefore much less stringent than those at mainland facilities, where the effluent is not so easily discarded. How would this affect diffusion through a porous membrane of otherwise identical gases
made from these isotopes? It contains many lecture ideas and topics not treated in the textbook as well as teaching tips and suggested step-by-step lectures and demonstrations. The light rays do not actually come from this point, so the image Image Object is called a virtual image. Heat can be subtracted from air by radiation to space, by the
evaporation of rain falling through dry air,* or by contact with cold surfaces. To explain these and a multitude of other facts about the Moon, scientists have pieced together the following probable scenario for its origin. Foliated metamorphic rocks have a layered appearance, like the parallel flakes, or plates, of mica. CHAPTER 1 PAT T E R N S O F M
OT I O N A N D E Q U I L I B R I U M CHECKPOINT A ball rolling along a level surface slowly comes to a stop. (c) depth of the lake. How many dimensions are there in spacetime? But what if the boxer were hitting a piece of tissue paper? The CO2 in the atmosphere brings the pH of rainwater to about 5.6— noticeably below the neutral pH value of 7
Nuclear deformation may result in repulsive electric forces overcoming In the nuclear attractive nuclear forces, in which forces and repulsive electric forces between attractive nuclear forces between attractive nuclear forces, in which forces and repulsive electric forces between protons. the shore of a lake, the conical wake generated by a supersonic aircraft spreads until it reaches the ground. An
effective way to increase the number of collisions is to increase the concentration of the reactants. In sodium 1 + ion for every chloride 1 - ion. The combined cooling effects of expansion and rapid mixing with cooler air allow you to hold * Where does the energy go in this case? Living organisms, for example
are complex systems of interacting biomolecules all functioning on the scale of nanometers. 9.8 Power Production 24. For low currents in the bulb, the heat that is produced may be enough to make the filament glow red or white-hot. Bells ring at a particular frequency, and tuning forks vibrate at a particular frequency—and so
do the electrons of atoms and * The relationship is c = f l, where c is the speed of light (constant), f is the wavelength. Although it was developed only within the past couple decades, scientists are excited by its explanatory powers. All the wavelength are the same medium. Do you exert an impulse to catch
the ball if it's traveling at the same speed? He cools by panting. C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R Oceanic-continental convergence occurs when an oceanic plate collides with a continental convergence occurs when an oceanic plate collides with a continental plate (see Figure 21.23b). In terms of force, Freddy's feet are brought up to speed when they make contact with the
moving board. Among other things, humans have dammed rivers, built irrigation systems, and caused pollution, extinctions, and global warming. A horizontally moving tennis ball barely clears the net, a distance y above the surface of the court. (c) the distance through which the multiplied force acts. FIGURE 10.42 Modes of vibration of a guitar
string. We see this effect at the seashore, as Figure 7.9 shows. Compare the temperature of the combination of two protons and two neutrons ejected by a radioactive nucleus. Relentless pressure between the two plates
continues, and it is slowly closing up the Mediterranean Sea. If you purchase a water pipe at a hardware store, the clerk doesn't sell you the water to flow through it. The Richter scale is more precise. Note that the components of incident light parallel to the surface are reflected, and the components perpendicular to the surface pass through the
surface into the medium. Which is your dominant eye? Is acceleration directly proportional to mass? Some 63% of American adults are unaware that the mass extinction of the dinosaurs occurred long before the first human evolved; 75% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotics kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill bacteria but not viruses; 57% do not know that antibiotic kill 
that electrons are smaller than atoms. The products of this neutralization eventually end up on the ocean floor as insoluble solids. CHAPTER 23 1. What are the three primary colors? 20.4 Classification of Rock-Forming Minerals 10. This is destructive interference. 341 FIGURE 13.33 INTERACTIVE FIGURE The mass of a nucleus is not equal to the
sum of the masses of its parts. Because there is no air above Earth's atmosphere for the rocket to push against. If you rub another straws near each other, the two straws repel. When straight-line motion is being considered, we can use the words speed and velocity interchangeably in the definition of
acceleration. The same change in momentum of the considerably more massive car is not evident because the change in speed up a bit, or will it continue at half speed and slow due to friction? Although testimonials about the benefits of magnets
are many, there is no scientific evidence whatever for magnets boosting body energy or combating aches and pains. Even students who shy away from mathematics can learn to read equations to see how concepts connect. Time slows down within a greater gravitational field. Stare at a piece of colored paper for 45 s or so. State how light is related to
electricity and magnetism. But even if you were able to slip into the pool. A sucrose-water solution containing 2 g of sucrose per liter of solution, for example, is more concentrated, and one containing only 0.5 g of sucrose per
liter of solution is less concentrated, or more dilute. These three laws first appeared in one of the most famous books of all time, Newton's Philosophiae Naturalis Principia. Aluminum metal wasn't known until about 1827, when it was prepared by reacting bauxite with hydrochloric acid. Hot-air
balloons use this strategy to rise or descend to a desired elevation. but occasionally the mutation results in cells that do not function as well as unaffected ones, sometimes leading to a cancer. Because electrons won't travel to a negative cathode on their own, they must be forced to do so. Air pressure at lower elevations is greater than air pressure
aloft, so the air parcel is compressed as it descends, causing it to warm up. The people who live into their 100s or 200s would not be frail and helpless. We would see a broad spectrum of colors rather than distinct lines. When you look at the electron-dot structure of an atom, you immediately know two important things about that element. How do
their average speeds compare? The reflection and refraction of P-waves through the core identified the solid inner core. Rocket ships lift off into space and campfires glow red hot as a result of exothermic reactions. Scientists have to be open to new ideas. 114. This gives the carbon a beta disintegration rate of about 13.5 decays per minute. (b) Two
nonpolar octane molecules are similar to methane, but they are longer. It is so important in the manufacturing of goods that its production is considered a standard measure of a nation's industrial strength. At sea level, 1 m3 of air at 20°C has a mass of about 1.2 kg. Yet, through some very advanced chemistry, his body is able to absorb the atoms of
that peanut butter sandwich and rearrange them into new materials. (c) an inward spiral path. A proton carries a positive charge and is relatively heavy—nearly 2000 times as massive as an electron. How could a lightbulb near, yet not touching, an electromagnet be lit? 7 Igneous Rocks 20. (b) Pascal's principle. Under this system, the Andromeda
galaxy is cataloged as NGC 224. chunk of pure U-235, however, no explosion would occur. It decreases to one-fourth, one-ninth, and one-hundredth the original value. The answer is simple enough: Their falls would be straight toward the Sun, and they would indeed crash into it. The nuclear equation is 90 144 91 143 234 90 234 91 Th Pa 0 -1 e 0 We
 write an electron as -1 e. Both paths curve equally in a uniform gravitational field. Refraction, sound The bending of a wave, either through a non-uniform medium or from one medium to another, caused by differences in wave speed. Acceleration is inversely proportional to mass. We see that, just as a current-carrying wire deflects a magnet such as a
compass needle, a magnet deflects a current-carrying wire. 20°C Saturated solution 78 g of NaNO3 in 100 mL water Solubilities of most solids, the solubilities of gases in liquids decrease with increasing temperature, as
Table 16.1 shows. Our bodies contain about 200 g of potassium. The perturbations of Uranus led to what greater discovery? The Sun's radiant energy stems from nuclear reactions in its deep interior. • Another most significant revision of this Fifth Edition lies with the development of the end-of-chapter review. This ever-soslight rise, and the
accompanying ever-so-slight increase in pressure at the bottom of the pool, is an ever-so-welcome signal to the hungry crocodiles. A note of caution is due when boiling water in a microwave oven. This, in turn, supports the theory that Venus lost its water because of a runaway greenhouse effect—if such didn't happen, then the proportion of
deuterium in the atmosphere would remain similar to that currently found on Earth. But there is no government commission of Franklins and Lavoisiers to challenge their claims. Refraction occurs when parts of the wave fronts of sound travel at different speeds and produce bending in the direction of the waves. The soil and underlying rock can
 actually increase the size, or amplitude, of seismic waves away from the epicenter. Of course, we all know that the Teflon is fairly easy to scrape out of the appliance is an electric motor, then applying too little voltage can result in overheating and
burn up the motor windings. Paul's grown children begin with son Paul on pages 150 and 167 and coauthor Leslie in her student days on page 318. If a fast marble bits a random scatter of slow marbles, does the fast marble usually speed up or slow down? 148 PARTONEPHY SICS CHECKPOINT 1. Because less weight is exerted on the outer
core, the pressure is lower there, resulting in a liquid phase of iron and nickel. (Hint: Find the distance to Alpha Centauri in units of AU.) CHAP TER 26 REVIEW 735 T H I N K A N D R A N K (A N A LY S I S) 42. What chemical has replaced them? 1 Vibrations and Waves 10. The atomic masses are average numbers that reflect the variety of isotopes
that exist for an S-13 element. The weight of the column of liquid directly above this area produces pressure. Ores of manganese, Mn, sometimes contain the mineral rhodochrosite, MnCO3, which is an ionic compound of manganese ions. But when they hit with their faces at right angles to the surface, they "refract" into the water
For the corresponding hang time, let's use 1.25 m for d, and the more precise value of 9.8 m/s2 for g. The Big Rip scenario assumes that dark energy will grow stronger over time. What effect would this have on Earth's climate? SAM PLE PROBLEM 1 What mass of water is produced when 16 g of methane, CH4 (formula mass CH4 + 2 O2 h CO2 + 2
H2O Solution: Step 1. With impurities in the water, the freezing point is lowered. (d) Clouds with vertical development: cumulous, cumulonimbus. Low Clouds are called stratus clouds. Note also that it makes no difference whether the projected coin moves along path A or path B. This is in accord with
the law of conservation of energy, which tells us that energy is neither created nor destroyed in a chemical reaction (or any process). REVIEW 765 27.6 Galaxies 24. Because jet exhaust is mainly carbon dioxide and water vapor, when the water vapor mixes with the cold environment of the upper troposphere, it can condense into small water droplets
to form a line of white "clouds." Study the length and thickness of the contrails. Lower two glasses in water, mouths downward. Atmospheric pressure decreases with increasing altitude, so a barometer can be used to determine elevation. Because of inherent inefficiencies, the generator will produce less electricity than is used by the adjoining motor
    power the generator. But if the numbers do not balance, the object is then electrically charged. In most midlatitude cyclones, the warm front (a) is behind and to the west of the cold front. HDPE holds its shape in boiling water; LDPE deforms. 16.2 The Chemist's Classification of Matter 4. That can be calculated as follows: (16 g O2)(1 mole O2/32 can be considered as follows).
O2)(1 mole CH4/2 moles O2) (16 g CH4/1 mole CO2/2 moles O2) (16 g CH4/1 mole CO2/2 moles O2) (14 g CO2/1 mole CO2/2 moles O2) (18 g CO2/1 mole CO2/2 moles O2) (18 g CH4/1 mole CO2/2 moles O2) (19 g CH4/1 mole CO2/2 moles O2) (19 g CH4/1 mole CO2/2 moles O2) (19 g CH4/1 mole CH4/2 moles O2) (19 g CH4/1 moles
Molten magma that moves upward from inside Earth and flows onto the surface. Heat, like work, is energy in transit and is measured in joules. Rank in order of decreasing number of people who have seen a: (a) solar eclipse, (b) lunar eclipse, and (c) new Moon. This is true not only of sound waves, but, as we'll see in the next chapter, of light waves
also. W ater, like most other substances, expands when heated. CHECKPOINT You open two cans of soft drink, one from a warm kitchen shelf and the other from the coldest depths of your refrigerator. This pull is enormously greater than the combined pull of all the planets, even when lined up in a row (as occasionally happens). (b) its atoms are
continuously being struck by alpha and beta particles. If we reverse the direction of current, the deflecting force acts in the opposite direction. The three oxide ions in Al2O3 carry a total charge of 6 - , which balances the total 6 + charge of the two aluminum ions. Aim a well-built spectroscope at the star and study its spectral patterns. The photo
shows science author Suzanne Lyons with her son Tristan wearing green. Look at Figure 21.32 and note the oblique line in the top drawing; this line represents a fault. We can state the answer in several ways. Every H2O molecule is exactly the same as every other, and there's no such thing as an impure H2O
molecule. This is best accomplished by rotating the coil in a stationary magnetic field (Figure 9.28). CHAPTER 6 REVIEW 163 R E A D I N E S S A S S U R A N C E T E S T ( R AT ) If you have a good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. On a skateboard, you'd recoil and gain
momentum when you throw the ball, you'd gain the same momentum when you catch the ball, and you'd gain twice the momentum if you did both—catch and then throw the ball at its initial speed in the opposite direction. (b) When salt is added to the water, fewer water molecules enter the ice and it melts along the surface. Why does dew form on
the ground during clear, calm summer nights? Your favorite young relative is wondering about joining a large and growing group in the community, mainly to make new friends. Freezing occurs when a liquid changes to a solid phase—the opposite of melting. * The numerical value of G depends entirely on the units of measurement we choose for
mass, distance, and time. A magnetic stripe on a credit card contains millions of tiny magnetic domains held together by a resin binder. Gravity changes the speed in going from D to B equals its gain in speed from B to D. Rank the events in order of oldest
to most recent: (a) star formation, (b) inflation, (c) Big Bang. He was comparing the tensions in both ropes—to determine which was greater. A common example is a satellite in a circular orbit; the force of gravity is at right angles to its circular path and no work is done on the satellite. Oceanic crust 10 km Mantle Continental crust 20-60 km Outer
core Inner core 2885 km 2270 km 1216 km 6371 km F I G U R E 2 1 .1 Cross-section of Earth's interior showing the four major layers and their approximate thicknesses. In other words, if gravity is the "pull inward," there should be a phenomenon that creates a "push outward." F I G U R E 2 8 .1 9 Ordinary matter condensed out of a mixture of dark
and ordinary matter. Nine times as much distance. One day, Harry was painting near a flagpole, and, for a change, he tied the free end of the rope to the flagpole instead of to his chair, as shown on the right. Go to it! Your conceptual physical science course really can be the most interesting, informative, and worthwhile science course available to
your students. Their specific heat capacities are listed here. What is it, exactly, that waves in a light wave? car interior radiates its own waves, but because it is not as hot as the Sun, the waves are longer. How did these medicines get there? The more evidence you have suggesting that a different material has been formed, the greater the likelihood
that the change is a chemical change is a chemical change. (a) The force of air resistance will be equal to her weight, mg, or 500 N. A plague swept through England, and Newton retreated to his mother's farm—this time to continue his studies. Even light energy originates from the motion of electrons within atoms. See also Phase changes by radiation, 168-171. When an
average force F is exerted over a certain distance on a shopping cart of mass m, its kinetic energy increases by 12 mv2. From May 21 to 26, a series of tornadoes touched down in areas of Minnesota, Kansas, Oklahoma, and Missouri, with by far the most catastrophic damage in Joplin, Missouri. In behaving as an acid, a water molecule donates a
hydrogen ion to a neighboring water molecule, which, in accepting the hydrogen ion, is behaving as a base. Which is it? ** The Latin title means "On the Revolutions of Heavenly Spheres." CHAPTER 2 2.2 Newton's Second Law of Motion EXPLAIN THIS What happens to a car's pickup when you increase your push N E W TO N 'S L AW S O F M OT I
O N 41 LEARNING OBJECTIVE Relate acceleration, Ov/Ot, to its cause, F/m. This descending air is dry because most of its moisture was removed in the form of clouds and precipitation on the windward side of the mountain. The raised level due to placing a stone in the container is the same as if a volume of water equal to the volume of the stone
were poured in. If 96% is transmitted through the first face, and 96% of 96% is transmitted through the second face, we have [(0.96)(0.96) = 0.92], so 92% is transmitted through the first face, and 96% of 96% is transmitted through the second face, we have [(0.96)(0.96) = 0.92], so 92% is transmitted through the first face, and 96% of 96% is transmitted through the second face, we have [(0.96)(0.96) = 0.92], so 92% is transmitted through the first face, and 96% of 96% is transmitted through the second face, we have [(0.96)(0.96) = 0.92], so 92% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the first face, and 96% of 96% is transmitted through the face of 96% of 96% is transmitted through the face of 96% of 96% is transmitted through the face of 96% of 96% is transmitted through the face of 96% of 96% is transmitted through the face of 96% of 96% is transmitted through the 96% of 96%
function change, but the evaporation rate increased. Your arm describes a cone, and your finger sweeps out a circle. Helium-filled toy rubber balloons usually break some time after being released into the air when the expansion of the helium they contain stretches the rubber until it ruptures. Figure 18.2 shows some familiar bases. Would you expect
this compound to be soluble or insoluble in roomtemperature water? When cooled, the basalt becomes new oceanic crust. 14.6 Naming Compounds 26. A number of tertiary processes are used, and most involve filtrations of some sort. How does a coulomb of charge compare with the charge of a single electron? Microwave ovens typically cook food
using microwaves with a frequency of about 3.00 GHz (gigahertz, 109 Hz). The Gulf Stream, a warm-water current in the North Atlantic Ocean, is actually part of a huge gyre. 172 PARTONEPHYSICSTHETHERMOS BOTTLE A common Thermos bottle, a doublewalled glass container with a vacuum between its silvered walls, nicely summarizes
heat transfer. You extend the time of impact and thereby reduce the force of impact and thereby reduce the force of a temperature inversion is commonly seen over a cold lake when visible gases and small particles such as smoke spread out in a flat layer above the lake rather than rising and dissipating higher in the atmosphere (Figure 25.6). Notice
the warmth of the air. The energy of a hot pan, for example, does not stay concentrated in the pan once the pan is taken off the stove. If you were running out of space? If you try this, use unbreakable dishes! FIGURE 2.3 Rapid deceleration is sensed by the driver,
who lurches forward—inertia in action! 40 PA R T O N E P H Y S I CS The Moving Earth Nicolaus Copernicus (1473-1543) FIGURE 2.4 Can the bird drop down and catch the worm if Earth moves at 30 km/s? But scientists whose
claims are without substance. What equation is most appropriate for determining the distance fallen each second? The most important difference between gravitational forces are only attractive. But the average speeds of most molecules in the
atmosphere are well below the escape speed, so the atmosphere is held to Earth by Earth's gravity. (b) From greater the difference in electronegativities between two bonded atoms, the greater the polarity of the bond, and so the order of increasing polarity is
S i F 6 P i F 6 Ge i F 70) and it is also the poorest country in the Western Hemisphere. system for naming the countless number of possible
compounds has been developed by the International Union of Pure and Applied Chemistry (IUPAC). Physical and Chemical Properties Why are physical changes typically easier to reverse than chemical changes? The electron-dot structures of elements in the same group have the same number of valence electrons. A burst as short as 10 s could have
led to the loss of Earth's protective ozone layer, thereby exposing life on Earth to dangerous ultraviolet rays from our Sun. This activity is neatly summed up in written form as a chemical equation. The hard water ions, calcium and magnesium, bind to the carbonate ions, which "softens" the water. When light emerges from these materials into the air,
it travels at its original speed. Wearing your leather shoes, scuff your way across the rug until your noses are close together. In the first step, the two fronts are joined at the center of a low-pressure area and they do not overlap. Freezing The process of changing phase from liquid to solid, as from water to ice. Q = cm$T = (1 cal/g # °C)(30 g)(30 °C -
20°C) = 300 cal. (a) When the end of the Slinky is pushed and pulled rapidly along its length, a longitudinal wave is produced. (c) The molten wax is pulled upward through the wick. For example, if a force acts at an angle to the motion, the component of force parallel to the motion is multiplied by the distance moved. CHAPTER 3 MOMENTUM AN D
ENERGY 63 with some other object. H30 \le CaCO3 2 Acid enters lake from rain. You say that nothing, no force, keeps the probe moving when the rocket disengages. Nonmetals are very poor conductors of electricity and heat, and may also be transparent. Remember that when we talk about the "boiling point" of a substance, we are referring to
a pure sample of that substance. A lunar eclipse occurs at the time of a full Moon, when the Moon and Sun are on opposite sides of Earth. Sun light 40° Violet Red Violet Water drops 42° Red * We're simplifying when we indicate that the red ray disperses at 42°. Images of the thyroid gland, such as the one shown here, can be obtained by giving a
patient the radioactive isotope iodine-131. Each year in the United States, about 25 billion pounds of sodium hydroxide are manufactured for use in the production of various chemicals and in the pulp and paper industry. Just as long pipes have more resistance than short ones, long wires offer more electrical resistance. They would continue doing so
until the deuterium grew sparse. If you added a few other ingredients to the solution, such as spices and the right kinds of microorganisms, you would have a pickle. Light rays bend. It emits more blue light than red light because of its high surface temperature. From the surface of Earth, escape speed is 11.2 km/s. There are usually two terminal
speeds: one before the parachute opens, which is faster, and one after opening, which is slower. (a) A simple distillation setup used to separate one component from a mixture. Terminal velocity Terminal speed in a given direction (often downward). So the gravitational force at the surface of a collapsing star increases because the star is getting
smaller. This attraction occurs between molecules that have a hydrogen atom covalently bonded to a Ion-dipole attractions FIGURE 15.32 Electrical attractions FIGURE 15.32 Electrical attractions are shown as a series of overlapping arcs. They look dark only in contrast with their 5800 K surroundings. Add a pinch of red Kool-Aid crystals to a still glass of hot water. Your old shipmates
are moving rather fast as well. In these cases of short impact times, the impact forces are large. One demonstrated solution to this problem is to raise the pH of acidified lakes and rivers by adding calcium carbonate—a process known as liming. Metamorphic rocks formed from preexisting rocks transformed by high temperature, high pressure, or both
—without melting. The one in the middle and the one on the right are actually two conformations of the same isomer. Earthquakes vary in their size and destructiveness. White dwarfs have the mass of a star but the volume of a planet, and are thus far more dense than anything on Earth. Weight The force that an object exerts on a supporting surface
(or, if suspended, on a supporting string), which is often, but not always, due to the force of gravity. Another new member of your discussion group says the primary reason astronauts in orbit feel weightless is because they are being pulled by other planets and stars. Sediments are deposited in horizontal layers, with each successive layer younger
than the one beneath it. Now it's your turn: Do all bullets drop the same vertical distance in equal times? With binoculars, the features of the Moon can be seen because they are lit by the sunlight reflected from Earth. Newton's birthplace was his mother's farmhouse in Woolsthorpe, England. CO2 CO2 Ocean pH ≈ 8.2 Freshwater lake pH < 7 CO2 §
H2O CO2 \le H2O H2CO3 Ca(HCO3)2 Deposits on ocean floor The pollution humans release knows no political boundaries. A ship sailing from the ocean into a freshwater harbor sinks slightly deeper into the water. In the second bowl, stir the yolk with a fork. (d) quadruples. Worldwide, desalination plants operate in about
120 countries with a combined capacity to produce about 45 billion liters daily. What is a Cepheid? Hint: One of these molecules has a triple bond. Poor conductors (such as glass, wool, wood, paper, cork, and plastic foam) are made up of molecules that hold tightly to their electrons. (Or do both cool at the same rate?) 14. In any case, the next time
you're taking a shower and the curtain swings in against your legs, think of Daniel Bernoulli. He asks his class to predict the relative brightnesses of two identical lamps in one wire about to be connected in parallel. This compound is actually not an insecticide. EXPLAIN THIS LEARNING OBJECTIVE Describe how a projectile can escape Earth's
influence. 09 016 M A This map shows the paths of total solar eclipses from 2006 through 2030. Volcanic rocks Extrusive igneous rocks formed by the eruption of molten rock at Earth's surface. "Strontium-90 is a pure beta source." How could a physicist test this statement? The only force acting on it is the force of gravity, which acts at right angles
to its motion (toward Earth's center). Do you? What is the major difference? Unlike the asthenosphere is rigid and brittle and does not flow. Use a ruler and rank these waves from greatest to least for (a) amplitude, (b) wavelength, (c) frequency, and (d) period. Could you do the same on pieces of red-hot iron? Here we present a visual
 "spring model" of the atom to help us understand the interaction of light with matter. m (c) hArt = Power Why do you run out of breath when running up stairs but not when walking up? HANG TIME REVISITED In Chapter 1, we stated that airborne time during a jump is independent of horizontal speed. Solar eclipse The phenomenon in which the
shadow of the Moon falls on Earth, producing a region of darkness in the daytime. Whereas the critical mass of fissionable material limits the size of a fission of 1 2 bomb (atomic bomb), no such limit is imposed on a fusion bomb (thermonuFIGURE 13.34 clear or hydrogen bomb). Warm conveyor belt The warm conveyor blows northward from the Gulf
of Mexico, and FIGURE 25.16 hence carries significant moisture with it. The strong man will be unsuccessful. Then take the 1 - charge of the chlorine and make it the subscript of the magnesium. Minerals such as quartz have a glassy luster, and minerals such as quartz have a glassy luster. They pull on each other equally. In the third picture (c), we
see that light is transmitted when a third Polaroid is sandwiched at an angle between the crossed Polaroids. wet region before it reaches your eye. Faulting Flow Shortening CHECKPOINT Why are rocks at the core of a syncline younger than those farther out from the core, while the opposite is true for an anticline? Corrosion is the process whereby a
metal deteriorates. The unit of electrical resistance is the ohm, symbol \(\chi\). (These relations are nicely developed in the Conceptual Physical Science Practice Book.) Force of hand accelerates the brick Twice as much force produces twice as much force produces twice as much force produces twice as much force produces.
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brick The same force accelerates 2 bricks 1/2 as much FIGURE 2.6 INTERACTIVE FIGURE Acceleration depends on both the amount of push and the mass being pushed. Electric shock can upset the nerve center that controls breathing. 647: NASA 652: (top left) PSD Photography/ Shutterstock 652: (bottom left) EROS Data Center, U.S. Geological
Survey 652: (middle) National Geophysical Data Center 652: (top right) Shutterstock 659: Laszlo Podor/Alamy 662: S
are pushed to the side that is farthest from the water molecule. Small, closely packed atoms have a smaller distance between them and thus form stronger bonds than do minerals in which the atoms are not so closely packed. The force of impact is only a third of what it would have been if he hadn't pulled back. Add about an inch of water to a large
test tube followed by a couple drops of phenolphthalein pH indicator, which you will likely need to obtain from your classroom. • FIGURE 4.7 The person's weight (not her mass) decreases as she increases her distance from Earth's center. The corona of the Sun is about as bright as the full Moon to those in the path of totality. Q = mLv = (200 g)(540 g
cal/g) = 108,000 cal. A familiar example of crystallization is ice crystals that form in water when the temperature drops below 0°C. Use Exercise 53 as an analogy to describe what occurs in Exercise 54. Knowledge can be gained by philosophical logic and also by experimentation. (c) hanging steady. Why does warm, moist air blowing over cold water
result in fog? You'd do 1600 J of work on it if you could lift it a vertical distance of 1 m. LEARNING OBJECTIVE Summarize the evidence for seafloor spreading, and describe the process of subduction. For fuel economy, stir your spaghetti in gently boiling water. Polarization occurs for waves that are (a) translational. The Submicroscopic World What
is found between two adjacent molecules of a gas? Your tutor tells you that an ampere and a volt really measure the same thing, and the different terms only make a simple concept seem confusing. The electric energy flowing from cloud to ground is lightning (Figure 25.18). Which is more symmetrical: a polar molecule or a nonpolar molecule? There
is relatively little bluffing in a game in which all bets are called. Alternatively, we might say that the great pressure forces the carbon dioxide molecules into solution. Of course, a burning deck of cards would produce the most entropy of all. This technique is common for cooks in the kitchen. If you were to stop breathing, say by choking, your cells
would be deprived of oxygen and no longer able to produce these high-energy molecules. How can a magnet attract a piece of iron that is not magnetized? The same principle applies to atoms. In Perspective Who gets the most out of something; one with understanding of it or one without understanding? Your friend says that the law of momentum
conservation is violated when a ball rolls down a hill and gains momentum. In 1867, Joseph Lister (1827-1912) discovered the antiseptic value of phenol, which, when applied to surgical instruments and incisions, greatly increased surgery survival rates. Exaggerated Moon Lever arm CM CG Torque exists when Moon's long axis is not aligned with CM
Earth's CM Earth FIGURE 26.29 When the long axis of the Moon is not alignment. Also, all gases are generally infinitely soluble in other gases because they can be mixed together in just about any proportion. How might perfluorocarbons be used to clean our
lungs or serve as artificial blood? Just as planets fall around the Sun, stars fall around the centers of galaxies. If so, does it increase or decrease? During radiation therapy, a patient may receive localized doses in excess of 200 rems each day for a period of weeks (Figure 13.7). Some atoms can form triple covalent bonds, in which six electrons—three
from each atom—are shared. Weather forecasting involves great quantities of data from all over the world. Investigation begins with the rocks on the surface, which tell us a great deal about Earth's interior. Oxidation and reduction are complementary processes that occur at the same time. Is it important to convert temperatures to the Kelvin scale
when we use Newton's law of cooling? Because of their extra mass, these clumps exerted a stronger gravitational force on one another than on neighboring regions of the disk, and so they pulled in even more material to them. 2 8 The NGC 6744 galaxy is an intermediate between a barred and unbarred spiral galaxy. Such physical stress occurs deep
in Earth's crust. Thermal expansion must be taken into account in structures and devices of all kinds. Why are common names often used for chemical compounds instead of systematic names? (a) When the boxer moves away (rides with the punch), he extends the time and diminishes the force. H O W ATO M S B O N D A N D M O L E CU L E S AT T R
AC T Sodium ion, Na Chloride ion, Cl (a) 15.4 Metallic Bonds EXPLAIN THIS I 375 Why aren't alloys described as metallic compounds? The pressure that the water exerts on the building is not reduced, as Bernoulli claims. The work-energy theorem applies to decreasing speed as well. (a) When a spacecraft enters FYI the atmosphere at too steep an
angle, more than about 6°, it can burn up. Can the Doppler effect be observed with longitudinal waves, with transverse waves, or with both? Its speed of departure from Jupiter. One way is by measuring a solution's VIDEO: Some Acids and Bases Are Stronger
Immediately after gaseous hydrogen chloride is added to water, it reacts with the water to form hydronium ions and chloride ions. Instead, the control center in effect asks, "Where is it now and what is its velocity? What does the expansion of space do to light passing through it? the front, the cirrus clouds descend and thicken into altocumulus and
altostratus clouds that turn the sky an overcast gray. d, 2. 0 00 x1 0 Saturn surrounded by its famous rings, which are composed of rocks and ice. Fluorescent lamps are richer in the higher frequencies, and so blues are enhanced in their light. The collision of objects clearly illustrates the conservation of momentum. When sucrose is added to a given
volume of water, the volume of the solution increases. You could ship these containers are not weighted down with water, shipping costs would be low. If you push a solid block along a floor to the right, the force of friction on the block will be to the left. Furthermore, the core guides more
magnetic field lines from the primary to the secondary. When the Sun is high in the sky, about 100 W of solar power enters the hole. Recall from previous chapters the luminosity of stars to their temperature, interesting patterns emerge. The voltage source simply
provides them with surges of energy. CHAP TER 26 THE SOL AR SYSTEM 717 Moreover, recall from Sections 9.5 and 21.2 that movements within Earth's molten core generate a strong magnetic field (E = F/q) required to
produce this force is 2 * 106 N/C. Why is the pressure in a car's tires slightly greater after the car has been driven several kilometers? As part of their training before going into orbit, astronauts experience weightlessness when riding in an airplane that is flown along the same parabolic trajectory as a freely falling projectile. F I G U R E 2 7. For
example, when the hammer exerts a force on the stake, the hammer is brought to a halt by the force the stake exerts on it. CHAPTER 2 N E W TO N (16 4 2 -17 2 7) On Christmas Day in the year 1642, the year that Galileo died, Isaac Newton was prematurely born and barely survived. Lightning
claims about 100 human victims per year in the United States alone. Weather is the state of the atmospheric stability or instability at any given place and time. Boil shredded red cabbage in water for about 5 minutes. CHAPTER 9 M AG N E T I S M A N D E L E C T R O M AG N E T I C I
N D U C T I O N 231 FIGURE 9.35 Voltage generated in power stations is stepped up with transformers before being transferred across country by overhead cables. Within the spectrum of visible light we are most sensitive to a greenish-yellow, which is why many emergency vehicles are commonly painted greenish yellow. And most important is the
material from which the wires were made. In the middle box, you should have drawn all the particles aligned as shown in the left side of the first box. total distance covered Average speed g travel time 34. Why will an ideal Polaroid filter transmit 50% of incident nonpolarized light? When atoms of different elements bond to one another, they make a
compound. Vibration A wiggle in time. Heat is transferred by the movement of fluids. In Perspective 16. The deeper it is immersed, the more water it displaces and the greater the buoyant force acting on it. For starters, the year would likely not be divided into 12 months. FYI Filament Insulator FIGURE 8.24 The conduction electrons that surge to and the greater the buoyant force acting on it.
fro in the filament of this incandescent lamp do not come from the voltage source. Balance these equations: (a) Fe(s) + O2(g) h Fe2O3(s) (b) H2(g) + WBr(aq) h Br2(l) + WBr2(l) + WBr2(l) + WBr2(l) + WBr2
which are stars that change their luminosity over short periods of time. It spans a wide use of analogies and intriguing situations, all with a user-friendly tone. The findings are empirical (gained from a wide range of experiments) and the predictions are approximate (also based on experiment). The atoms within the individual sheets are connected by
strong bonds, but between the sheets, the bonds are weak. If the pressure increases to 1053 mb without changing the temperature or the water-vapor content of the air, what is the relative humidity? Hewitt 374: (top) iStockphoto 374: (bottom left) iStockphoto 374: (bottom right) Fotolia 375: Dee Breger/Photo Researchers, Inc. In what way is the
rule for the interaction between magnetic poles similar to the rule for the interaction between electric charges? People who drink bottled water should know of its hefty ecological price tag. A reduction in the amount of coastline lowers sea level and exposes more of the continental shelf, thus endangering shallow marine organism habitats. Structural
isomers have different arrangements of their carbon atoms, but the number of carbon atoms in each is the same. The helium is less soluble in the bodily fluids, so less dissolves for a given pressure. An example is the alkaloid caffeine, shown here reacting with phosphoric acid. G alileo tested his revolutionary idea by experiment. If these continents
were in their present positions, the ice sheet would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the equator! An ice sheet that extensive would have had to cross the extensive would have had to cross the
18 T W O CL A S S E S O F CH EM I C A L R E AC T I O N S Further experiments reveal an interesting rule pertaining to the concentrations of hydronium and hydroxide ions in any solution that contains water. We might think that the change of potential energy would be infinite because the distance is infinite. As discussed in Section 14.5, sodium
Einstein was struggling to understand why gravity wasn't causing the universe to collapse in a Big Crunch. Instead, in accord with Newton's first law, it tends to continue at the speed it had when the engine stopped running, half speed, decreasing further over time due to air resistance and road friction. 2 7 The toy drinking bird operates by the
evaporation of ether inside its body and by the evaporation of water from the outer surface of its head. If matter is made of atoms and atoms are made of subatomic particles, what comes together to create subatomic particles? When we combine the ideas of inertia and motion, we are dealing with momentum. As fast-moving molecules in a liquid
escape into the air, slower ones on average are left behind, thereby cooling the water. FYI 76 PA R T O N E P H Y S I CS FIGURE 3.25 Cable cars on the steep hills of San Francisco nicely transfer energy to one another via the cable beneath the street. 124 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Relate the weights of a submerged body and
displaced water to the buoyant force. It struck the Gulf Coast of the United States six days later, wreaking havoc. The internal voltage drop increases with current S-10 O D D - N U M B E R E D S O LU T I O N S in the battery, which means reduced voltage supplied at its terminals to the circuit it powers. These regions receive twice as much solar
energy as polar regions. They can easily step over a 0.5-m fence, but in doing so, their bodies rise only slightly. Water can rise to the level of the water table, until it is pumped. If you toss a coin straight upward while riding in a train that travels at uniform and steady motion along a straight-line track, where does the coin land? (d) stable at Earth's
surface. 10.2 Wave Motion EXPLAIN THIS How does wave speed relate to frequency and wavelength? Just how polar a bond is depends on the difference between the di
Grace opens the astronomy chapters on page 707. The quake and its aftermath caused 131 deaths and $300 million in damage.* Some of the greatest tragedies of recent times include the August 1999 earthquake in India (magnitude 7.9; 20,000 deaths), the December 2004
earthquake in Sumatra (magnitude 9.2; 280,000 deaths in 14 countries*), the February 2010 earthquake and tsunami in Japan (magnitude 9.0; 14,500 deaths and approx. For example, the 1964 Anchorage, Alaska, earthquake (magnitude 9.2) was the largest earthquake in North
America and the second largest ever recorded. Head-on, the impact speed is 198 km/h, lethal! 85. Duane Ackerman's daughter Charlotte opens Part 1 on page 13. 5 Elements to Compounds 14. The rounding occurs because chemical weathering is faster where surface area is greater, and corners and edges have the most surface
area. Terrestrial radiation The radiant energy emitted by Earth. Is this an example of a physical or chemical change? We begin our study of light by investigating its electromagnetic properties, how it interacts with materials, and how it reflects. T H I N K A N D R A N K (A N A LY S I S) 49. (b) From longest to shortest times, rank their order in
reaching the ground. As magma cools, high-melting-point and low-silica minerals crystallize first. This reaction gave the aluminum metal acting as the reducing agent: Al3+ + 3 Na + FIGURE 18.30 The electrolysis of water produces hydrogen gas and oxygen gas in a 2:1 ratio
by volume, in accord with the chemical formula for water: H2O. Through careful analysis, scientists find that the energy released by an earthquake increases about 30 times for each 1-point increase in magnitude. Such deposits are called ores. Are the chemical reactions that take place in a disposable battery exothermic or endothermic? In nuclear
fusion reactions, the net result is more tightly bound nuclei. So alpha radiation results in the greatest change in atomic number, and hence charge, and mass number as well. Gases expand when heated, and they contract when cooled. Why can wastewater treatment requirements in Hawaii be less stringent than those in most locations on the U.S.
mainland? Water at the bottom of an ice-covered pond is 4°C, which is relatively warm for organisms that live there. The masses are the same. A Motion of air relative to ball A familiar sprayer, such as a perfume atomizer, uses Bernoulli's principle. The blueness is of the low-altitude "sky" between us and the mountains. Amazing? Sunspots
Temporary, relatively cool and dark regions on the Sun's surface. What does Earth's curvature have in common with the speed needed for a projectile to orbit Earth? As early as the 1750s, the German philosopher Immanuel Kant proposed that these spiral clouds were other islands of stars called galaxies. If we could, we could, we could "see" why our income
buys only half of what it did 4 years ago, why the price of everything has doubled in the same time, why population, or the rate of consumption of a resource steadily grows at a fixed percent per year, we say the growth is exponential. (c) only
microscopic phenomena. Depending on your location, your water may contain compounds of calcium, magnesium; trace amounts of cadmium; organic compounds of lead, mercury, and cadmium; or
(Figure 2.24). Why is it easier for the body to excrete a polar molecule? Weight is measured in units of force (such as pounds). FYI Nuclear Fission Reactors The awesome energy of nuclear fission was introduced to the world in the form of nuclear bombs, and this violent image still colors our thinking about
nuclear power, making it difficult for many people to recognize its potential usefulness. Show that 9300 cal is required to change 15 g of 20°C water to 100°C steam. The terms are misleading because they imply that ultraviolet and infrared are forms of visible light. Luckily, at 11:59 A.M. they discover three new empty bottles, three times as much
space as they had ever known. When a standing wave is set up in a rope, for example, parts of the rope have no amplitude—the nodes. It is only because of Earth's enormous mass that you don't notice its upward acceleration. It's not always easy to distinguish between the two. (d) simple harmonic motion. By how much does the gravitational force
between two objects decrease when the distance between their centers is doubled? Work done on the satellite by the gravitational force is zero. It's not, however, that oil and water repel each other. When a chemical loses a hydrogen ion, is it behaving as an acid or a base? REVIEW 319 80. 288 PA R T O N E P H Y S I CS 11.6 Dispersion 24. Of
course, the same is true without the bamboo pole. Initial position Final Position
more so in part (e). e \ge e - Cl \ge Cu \le Cl \ge \mu FIGURE 18.22 An iron nail is placed in water and connected by a conducting wire to a solution of copper ions. What is the hydronium-ion concentration? The mass of this air is found by multiplying the density by the tank volume: (1.25 \text{ kg/m}^3)(0.0100 \text{ m}^3) = 0.0125 \text{ kg}. (d) They hold many clues to
Earth's natural history. If you swim twice as deep, twice the weight of water is above you, so the water's contribution to the pressure you feel is doubled. Calculate the impulse of a cart when an average force of 10 N is exerted on it for 2.5 s. (b) two terms for the same concept. The compound sodium chloride, NaCl, is a translucent, brittle, colorless
crystal with a melting point of 800°C. The forces in Figure 1.10 are shown by arrows. Why aren't atmospheric levels of carbon dioxide resulting from human activities? Diurnal motion is easy to visualize as a rotation of the celestial sphere from east to west. (a)
Opposite poles are nearest to each other. Wobbling protons are slammed with a burst of radio waves tuned to push the proton's spin axis sideways, perpendicular to the applied magnetic field. Force is increased and distance is decreased. In 1676, the Danish astronomer Ole Roemer had one of those "Aha!" moments in science. These materials are
called compounds, which we discuss further in Chapter 14. A composite cone (also known as a stratovolcano) is a volcano built up of alternating layers of lava, ash, and mud. Rank the solutions in order of increasing concentration = 2 M); (b) acetic acid, CH3COOH (concentration = 2 m); (c) acetic acid, CH3COOH (concentration = 2 m); (b) acetic acid, CH3COOH (concentration = 2 m); (c) acetic acid, CH3COOH (concentration = 2 m); (d) acetic acid, CH3COOH (concentration = 2 m); (e) acid, CH3COOH (concentra
2 M); (c) ammonia, NH3 (concentration = 2 M). A supersonic bullet passing overhead produces a crack, which is a small sonic boom. VIDEO: Polar Attractions its attraction to neighboring molecules. The densities of some minerals are shown in Table 20.2. Gold's particularly high density of 19.3 g/cm3 is nicely taken advantage of by miners panning
for gold. The refinement of theories is a strength of science, not a weakness. A piece of solid aluminum sinks in a container of molten aluminum. 10 N of air resistance? (a) (b) 68. We will not explain the mathematics here, but we will simply point out that, by such analysis, one can find the pure sine tones that constitute the tone of, say, a violin. (e) 100
times as much. Can we correctly say that hydrogen is a relatively new source of energy? Add the cooled blue broth to at least three cups of clear water so that each cup is less than half-filled or to three white porcelain bowls. a result of chemical impurities. For decades, it was generally thought that zero electrical resistance could occur only in certain
metals near absolute zero. I magine some fantastic optical instrument through which we can see the actual history of human civilization. If the gradient increases 10 times as well. We can see the regions in which the crest of one wave overlaps the trough of another to produce a region of
zero amplitude. In making this solution, should she add the solvent to the solvent to the solvent to the appliance, and you touch the appliance to the appliance and you touch the applicance and you touch the appliance and
quantity of matter in things (their mass) by their gravitational attraction to Earth (their weight). The redness of a sunrise or sunset is due mostly to light that hasn't been (a) absorbed. If gravity did not act on the ball, the ball would follow a straight-line path shown by the dashed line. For boiling water? At this first refraction, the light is dispersed into
its spectrum colors, red being deviated the least and violet the most. What does \boxtimes F = 0 mean? Why do nonpolar substances boil at relatively low temperatures? The atoms in the baseball would be the size of Ping-Pong balls. C H A P T E R 11 LIGHT 271 F I G U R E 11 .1 3 (a) (b) (a) The virtual image formed by a convex mirror (a mirror that curves
outward) is smaller and closer to the mirror than the object. In a technique called cathodic protection, iron structures can be protected from oxidation by placing them in contact with certain metals, such as zinc or magnesium, that have a greater tendency to oxidize. When you leap upward, jumping force is applied only while your feet are still making
contact with the ground. How does the frequency of induced voltage compare with how frequently a magnet is plunged into and out of a coil of wire? (a) (b) 45. What would happen next is only conjecture. Two force fields are gravitational and electric.
near the right-hand end—and doesn't this mean that the speeds of balls A and B will be the same at the ends of both tracks? Just as the three colors red, green, and blue can be combined to form any color on a television screen or the 26 letters of the alphabet make up all the words in a dictionary, only a few kinds of atoms combine in different ways to
produce all substances. The force then diminishes as the ball comes up to speed and returns to its original shape. The hot vapor flows into the bottom of a fractionating tower, which is warmer at the bottom than at the top. Be sure to include the fields of medicine, transportation, and communication. We have no trouble distinguishing between the
tone from a piano and the tone from a clarinet of the same musical pitch (frequency). Such devices are called voltaic cells. It also measures surface temperatures, magnetic fields, and the size, speed, and trajectories of tiny surrounding space particles. Sand has a low specific heat capacity, as evidenced by the relatively large temperature changes for
small changes in thermal energy. The force that acts on a moving charged particle, such as an electron in an electron in an electron in an electron beam, does not act along the line that joins the sources of interactive forces between the molecules no longer hold them together. If
launched at an angle, the vertical component of velocity is zero at the top, leaving only the horizontal component. Because of the blockage, Earth and the greenhouse get warmer. Why don't chain reactions occur in naturally occurring uranium ore deposits? The relative magnitudes of these components in comparison to the magnitude of F can be seen
in the imaginary rectangle they compose: f and f \Leftrightarrow are the sides, and F is the diagonal. The four largest moons were discovered by Galileo in 1610; Io and Europa are about the size of our Moon, and Ganymede and Callisto are about as large as Mercury (Figure 26.16). And we recombine various groupings of these pure tones when we listen. Different
configurations result in different chemical structures. Mountains, like icebergs, are Continental crust Oceanic crust Mantle bigger than they appear to be. The boxer's fist can exert only as much force on the tissue paper as t
trend. The result of twice as many coulombs is twice as much electric potential energy because it takes twice as much work to put the charge there. Adding the fifth straw across the middle gives the frame more support. A 50-N loss in one would be accompanied by a 50-N gain in the other. With more stress, the wax layers continue to deform until
changes. Wood is a better insulator than glass. 1.2 Galileo's Concept of Inertia EXPLAIN THIS Does a hockey puck need a force to keep it sliding? What is the buoyant force on the rock? The escape speed from the surface of our Sun is 618 km/s. Voltage doesn't go anywhere, for it is the charges that move. In the smallest force? During this process, no
atoms are lost, so the total mass of the polymer is equal to the sum of the masses of all the monomers. A glacier abrades and picks up everything in its path, so glacial deposits are characteristically composed of unsorted rock fragments in a variety of shapes and sizes. If you have a microscope, crush the crystals with a spoon and examine the resulting
powder. There was no time or space outside of this primordial event. Toward the lower left are some stars that are so dim they cannot be seen with the unaided eye. Sometimes there are as many as seven solar and lunar eclipses in a year. Acceleration needs an interaction with an external force. The greater field means a greater magnetic field
change in the primary and a higher voltage induced in the secondary. A chemical equation shows the reactants h products reactants h products reactants and products are represented by their elemental or chemical formulas. Rather the
heavy traffic. 13.5 Nuclear Fission 16. Because magnetic fields cannot penetrate the surface of a superconductor, magnets levitate above them. One of the arguments against a moving Earth was the following: Consider a bird sitting at rest on a branch of a tall tree. 19.2 Unsaturated Hydrocarbons 5. By Newton's law of cooling, the hot poker in the
cold room radiates more because of the greater temperature difference between the poker and the room. Hence the reason for padded dashboards and airbags in motor vehicles. When the pressure in the jar is slowly reduced by a vacuum pump, the water begins to boil. Going from very small grain size to larger grain size, the three most abundant
clastic sedimentary rocks are shale (which for our purposes includes mudstones), sandstone, and conglomerate (Figure 20.28). What are some possible reasons for this? If each jelly bean represents an electron, who ends up being slightly negative? Also, Pluto is quite small, being only one-seventh as massive as our Moon. The atom is electrically
polarized. So the less-dense continental crust always sits higher than the more-dense oceanic crust, even if the continental crust has more mass. There's a twist, however, in that dark energy causes the expansion of space, not contraction. (c) They tend to be found in scenic mountainous regions. Because water has such a high boiling point, however, in that dark energy causes the expansion of space, not contraction.
this technique is energy intensive. 74. Twice as far from the rotational axis, the speed is twice as great. Collisions between galaxies, however, are fairly common, and astronomers have photographed many such occurrences now in progress. What did general relativity predict about the orbit of Mercury? Are automobile headlights wired in parallel or
in series? R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 15.1 Electron-Dot Structures 1. Relate this to the phases of the Moon. The air that touches these surface "hot spots" becomes warmer than the surrounding air, and so it rises, expands, and cools. In all measurements to date, objects have a charge that is a whole-number
multiple of the charge of a single electron. Why does a battery that has thin zinc walls last longer than one that has thin zinc walls? Hewitt 230: (top) Lillian Lee/Paul G. Elasticity is related to how rigid and springy a material is. Noble gases 3 B Halogens 13 14 15 16 17 Chalcogens Alkaline-earth metals 2 Alkali metals As the tungsten filament inside
a lightbulb is heated, minute particles of tungsten evaporate. The focus is on comprehension before computation. In our example the resource is space—but it could as TA B L E C. (Recall that a hydrogen atom is a proton together with an electron. This steam may be used for heating or for generating electricity in a steam turbine. Although Newton's
hair turned gray at age 30, it remained full, long, and wavy all his life. The resistance of one's body depends on its condition, and it ranges from about 100 \( \frac{1}{3}\), if it is soaked with salt water, to about 500,000 \( \frac{1}{3}\), if the skin is very dry. Consider, for example, the case of a freight car moving along a track and colliding with another freight car at rest (Figure
3.13). Say, for example, he needs the same number of carbon atoms as oxygen molecules. A black hole? Notice that this answer applies to all situations in which a steady applied force is opposed by a steady frictional force. Astronomers now suspect that Triton is a Kuiper belt dwarf planet pulled off course and captured into orbit around Neptune.
Quartz (SiO2), the second most common mineral in Earth's crust, is composed of only silicon and oxygen. True or False: The more shells in an atom, the lower its electronegativity. To date, 12 people have stood on the Moon. As we shall see, cumulonimbus clouds often become thunderheads. (d) infinite mass. That's the electric current running
between the two metals. The chromosphere is hotter than the photosphere, reaching temperatures of about 10,000 K. F I G U R E 2 6 .1 2 CHECKPOINT If Venus was also once protected by the carbon dioxide cycle, what went wrong? Ellipse The oval path followed by a satellite. This is because the wind will not make impact against the sail if the boat
is moving as fast as the wind. Low-density gas is used in a balloon for the same reason that cork is used in life preservers. See Organic compounds Compression waves, 242 Concentration, 403 Condensation, 175-176, 685 Condensation polymers, 510-512 Conduction, 165-166 Conductors, 195 Configuration, molecular, 491 Conformations
491 Conservation laws, 69 Conservation of energy, 76 for machines, 78 Conservation of energy, 78 Conservation o
distance is 3 meters, not 5 meters. A reverse fault has a steep dip, 6 45°; a thrust fault has a gentle dip, 7 45°. The atmosphere of Venus is about 96% CO2. Yes, but not to any large extent. Why are ores so valuable? Is baking soda, NaHCO3, an ionic compound? Here the circle, representing 1 year, is divided into 12 parts—the monthly constellations
N N E W TO N 'S L AW S O F M OT I O N 47 LEARNING OBJECTIVE Define Newton's third law of motion by giving examples. What happens to the amount of the Sun's mass as it "burns"? Reinforcement F I G U R E 1 0 .1 9 Cancellation Constructive and destructive interference in a transverse wave. This is due to the average release of about 0.03
J/kg each year. How does it differ from a modern value for the speed of light? (b) The doubly positive calcium and magnesium ions of hard water preferentially bind with the doubly negative carbonate ion, freeing the detergent molecules to do their job. Likewise, the speed of light in glass is less because of the time delays in interactions with atoms
along its path. (c) gas phase. CHAPTER 8 S TAT I C A N D CU R R E N T E L E C T R I CI T Y By contrast, when you buy "an electron pipe," an electron pipe," an electron pipe," an electron pipe, and 6.02 * 1023 CO2 molecules in 44.009 g of
carbon dioxide, CO2 (formula mass = 44.009 amu). Similarly, the concentrated chemical energy in gasoline disperses in the formation of many very hot, smaller molecules that scatter explosively. The shadow is a region where no waves are detected. One hemisphere always faces us. Perhaps there was a moment at which the universe itself was born.
However, when chlorine atoms act as a catalyst, the energy barrier is lowered, as shown in Figure 17.14b, and the reaction can proceed faster. Similarly, in a gaseous mixture of heavy molecules with the same average KE, can you say which have the greater speed? The iron core in the secondary further increases the changing
magnetic field through the secondary and further increases the secondary voltage. Increased pressure, temperature, and water content greatly affect a rock's response to stress. c, a, d, b. If you wish to warm 50 kg of water by 20°C for your bath, show that the quantity of heat needed is 1000 kcal (1000 Cal). Habitats that lazily rotate as giant wheels
or Weight Support force FIGURE 4.8 Two forces act on a weighing scale: a downward force of gravity (your weight, mg, if there is no acceleration) and an upward support force. If we do 100 J of work, the forces of friction acting through the distances through which the pulleys turn and rub about their axles may dissipate 60 J of energy as heat. Co ld
Co Cold Warm Warm (a) Front develops Warm (c) Cyclonic circulation established (b) Wave develops L L (d) Occlusion begins So why do we call the contact zone between air masses a front? It would take 100 million years. This is like asking which is longer: a 1.6-km-long track or a 1-mi-long track. This matching of monthly spin rate and orbital
revolution rate is not a coincidence. In this way, a magnet attracts unmagnetized pieces of iron (Figure 9.9). The spot has now disappeared. However, with increasing concentration of CO2 in the atmosphere, we may experience higher average temperatures. (b) a = m 4.0 kg 4.0 kg kg 53. (c) Both. FIGURE A.5 The entire disk rotates at the same
rotational speed, but ladybugs at different distances from the center travel at different tangential speeds. The cold surface cools the air by conduction, and the warm air's ability to hold water vapor decreases. The force of gravity between two planets depends on their (a) planetary compositions. Why does a piece of watermelon stay cool for a longer
time than sandwiches do when both are removed from a picnic cooler on a hot day? Just when it returns to its initial position, (e) the next compression arrives to repeat the cycle. When the radio waves pass and the protons quickly return to their wobbling pattern, they emit faint electromagnetic signals whose frequencies depend slightly on the
chemical environment in which the proton resides. Celebrate that! CHAP TER 27 S TA R S A N D G A L A X I E S 763 FIGURING PHYSICAL SCIENCE The Scale of the Galaxy SAM PLE PROBLEM 1 Earth is about 0.000016 light-year from the Sun and about 4.2 lightyears from the next nearest star, which is Proxima Centauri. While a couple breaths
can neutralize a pinch of washing soda, it would take quite a while to neutralize a tablespoon full. Agree with your friend. O H3C CH3 N N O Most pharmaceuticals that can be administered orally contain nitrogen heteroatoms in the water-soluble salt form. If you start with a 1-g sample of the element at noon, how much of this same element will be
left at 3:00 PM? (a) 3 Hz; (b) 2 m; (c) Wave speed = frequency * wavelength = 3/s * 2 m = 6 m/s. This quadruples the total resource space ever known to TA B L E C .1 Time THE L AST MINUTES IN THE BOT TLE Part Full (%) Part Empty 11:54 A.M. 1/64 (1.5%) 63/64 11:55 A.M. 1/32 (3%) 31/32 11:56 A.M. 1/16 (6%) 15/16 11:57 A.M. 1/8 (12%) 7/88 [1.5%]
11:58 A.M. 1/4 (25%) 3/4 1/2 (50%) 1/2 11:59 A.M. 12:00 noon full (100%) none FIGURE C.2 A-14 APPENDIX C the bacteria, for they now have a total of four bottles, whereas before the discovery they had only one. a, 2. All of the heat going into the can increases the thermal energy of the enclosed air, so its temperature rises. CHECKPOINT If you
scuff electrons onto your shoes while walking across a rug, are you negatively or positively charged? In the future, commercial buildings as well as individual homes may be outfitted with fuel cells as an alternative to receiving electricity (and heat) from regional power stations. Liquid water forms on microscopic particles of dust, smoke, and salt—
cloud condensation nuclei—and this creates a cloud. The chemical change in which molecules of methane and oxygen transform to molecules of methane and oxyge
poles both attract and repel each other. Phenol An organic molecule in which a hydroxyl group is bonded to a benzene ring. Would you expect to find any fossils in limestone? A thin sheet of gold atoms, by contrast, is dark red. The bowling ball rolls at constant speed along the lane. This is isostatic balance—the upward-acting buoyant force of the
 asthenosphere equals the weight of the entire lithosphere. The "bullet of light" (photon) that is incident upon glass is absorbed by its interaction with an atom or molecule. (Courtesy of Michael Vollmer.) CHECKPOINT 1. As rising material from the mantle oozes upward, new lithosphere is formed. with which (a stone) is projected, the farther it goes
before it falls to the Earth. An undernourished person who performs extra work does so by consuming stored chemical energy in the body—something that cannot occur very long without losing health, and life. These clusters of different sizes result in a variety of scattered colors. This zone is solid but contains small amounts of liquid derived from the
partial melting of mantle rocks. In every event, whether large-scale or at the atomic and nuclear level, the principle of conservation of charge applies. The mathematician requested a single grain of wheat on the first square of the chessboard, two grains on the second square, four on the third square, and so on, doubling the number of grains on each
succeeding square until all squares had been used. Terminal speed for a human skydiver varies from about 150 to 200 km/h, depending on weight, size, and orientation of the body. You see an image of the candle at this point. A steel tank filled with helium gas doesn't rise in air, but a balloon containing the same helium easily does. We say that the
sediments lithify—they undergo lithification, a term that means "conversion into rock" (lith = rock). Show that the resistance of the device is 6 \(\frac{1}{3}\). Time's arrow always points from order to disorder.* The idea of ordered energy spreads to
disorder in a system. I2 + 2 Br - h 2 I - + Br2 69. This equivalence would be interesting but not revolutionary if it applied only to mechanical phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena, but Einstein went further and stated that the principle holds for all natural phenomena as well.
fuel than small-mass stars, but they consume their fuel so much faster that they die billions of years younger than smaller stars. These sacrificing metals, therefore, are sometimes called sacrificial anodes. A few words of explanation about each of the major divisions of science: Physics is the study of such concepts as motion, force, energy, matter,
heat, sound, light, and the components of atoms. A gas takes the shape of its container. In addition, methanol is used as a solvent, an octane booster, and an anti-icing agent in gasoline. The burning of wood is an oxidation-reduction reaction, as are the reactions your body uses to transform the food you eat into biochemical energy. s#s s2 m s m s 1 s
= CHAPTER 1 PAT TERNSOFMOTIONANDEQUILIBRIUM 29 CHECKPOINT In 2.0 s a car increases its speed from 60 km/h to 65 km/h while a bicycle goes from rest to 5 km/h while a bicycle goes from rest to 5 km/h while a bicycle goes from 60 km/h to 65 km/h while a bicycle goes from rest to 5 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h while a bicycle goes from 80 km/h to 65 km/h 
electrons. Similarly, chemists have refined their view of the way molecules bond together, and biologists have refined the cell theory. Friend from teen years, Paul Ryan sweeps his finger through molten lead on page 180. Point your camera toward the Sun. Coal is a chemical sedimentary rock or, more specifically, a biochemical rock. Today we know
the atom is made of smaller, subatomic particles—electrons, protons, and neutrons. Recall that a hydrogen atom consists of one electron surrounding a one-proton nucleus. When the light grazes the surface and bends upward, the observer sees a mirage. * Hydrothermal activity is rich in rare metals. Metamorphism The changes in rock that happen as
physical and chemical conditions change. First, without the tube, whistle from a high pitch to a low pitch. F I G U R E 1 5 .1 4 The world's biggest open-pit mine is the copper mine at Bingham Canyon, Utah. CHAPTER 8 8.2 Coulomb's Law 7. Impulse-momentum relationship Impulse is equal to the change in the momentum of an object that the
impulse acts upon. This is what happens in the atmosphere. Momentum is proportional to speed; KE is proportional to speed squared. An aluminum ion carries a 2 - charge, and an oxide ion carries a 2 - charge, and the flow of electrons ceases. Why does the fluorine atom tend to gain only one
electron? As you descend toward the black hole you note that your clock runs perfectly normally without changing color. The changes in density occur because the volume of a given mass of air is made smaller by compression and larger by expansion. Your study partner says he doesn't believe in Bernoulli's principle and cites as evidence how a
stream of water can knock over a building. As shown in Figure 16.16, for example, a sucrose molecule has many polar hydrogen-oxygen bonds. In accord with the law of conservation of angular momentum, these tiny bodies, with densities hundreds of millions times greater than those of white dwarfs, can spin at fantastic speeds. The North Star
appears stationary as the celestial sphere rotates because it lies very close to the projection of Earth's rotational axis. What happens to you? The water itself goes nowhere. The force of gravity on the distant Earth. 750 PA R T F O U R ASTRONOMY F I G U R E 2
7.1 6 This image of the 1987A supernova was captured by the Hubble Telescope about 20 years after the initial explosion was sighted. Point bar A sandy, gentle bank on the inside bend of a river's channel; an area of deposition. What is the approximate distance of a thunderstorm when you note a 3-s delay between the flash of lightning and the sounds.
of thunder? It is common to express rotational rates in revolutions per minute (rpm).* Phonograph records that were common a few years ago rotate at 33 1/3 rpm. But the droplets are repeatedly bombarded from below by smaller droplets are repeated from below by smaller droplets.
and surface waves, which travel along Earth's surface (Figure 21.3). What is the net force on an apple that weighs 1 N when you hold it at rest above your head? (0.03 m)2 kq 2 43. Energy is charge * potential: PE = qV = (2 C)(100 * 106 V) = 2 * 108 J. But this is not what astronomers observe. 209 84 Po S 82 Pb + ?? You are free-floating in a
spaceship at uniform motion deep in outer space. Other examples are force, acceleration, and momentum. FIGU R E 15. These problems, however, are not the fault of technology any more than a stabbing is the fault of the knife. Electronics technicians frequently wear clothing of special fabrics with ground wires between their sleeves and their socks
A good rule is to touch metal to discharge static charge from your body before you fuel. The oceans are great reservoirs nally had. In the space between the atoms in matter, the instantaneous speed of light is c. Is it correct to say that an electric motor is a simple extension of the physics that underlies a galvanometer? It's okay not to know the
answers to fundamental questions. So: FYI V = mv m 68 PA R T O N E P H Y S I CS F I G U R E 3 .11 A cue ball hits an eight ball head-on. A similar jump is made in the seventh period. Residents of Mexico. Of course, it was once thought that Earth was the center
of the universe. Are alkaloids found in nature? WAV E S A N D S O U N D 239 LEARNING OBJECTIVE Distinguish among amplitude, wavelength, frequency, and period. Why this is so, for any mass, awaits you in Chapter 3. A-16 APPENDIX C QUESTIONS TO PONDER 1. Because of this, the brittle lithosphere is broken into many individual pieces
called plates. It then follows that I = V/R, or R = V/I, so that, if any two variables are known, the third can be found. F I G U R E 3 .1 5 He may expend energy when he pushes on the wall, but if the wall doesn't move, no work is done on the wall. How much friction acts on the desk? By shaking the rope just right, you can cause the incident and
reflected waves to interfere and form a standing wave, in which parts of the rope, called the nodes, are stationary. In all cases the ET question should serve well as a launching point for classroom discussions. The Milky Way's Fermi bubbles, however, are minor compared to the activity we see arising from the centers of other large galaxies. Recall
that a homogeneous mixture consisting of a single phase is called a solution. Try it and see. F I G U R E 1 9 .1 3 Every phenol contains a phenolic group (highlighted in blue). Amazingly, your eye does some of your "thinking." A mirage occurs when refracted light appears as if it were reflected light. Minimum deflecting force? Suddenly the ball starts
moving to the floor. But so far, energy conservation is as solid as any knowledge we have. Each pair is brought together, allowed to touch, and then separated. Altostratus clouds are often so thick that they diffuse incoming sunlight to the extent that objects on the ground don't produce shadows (they also don't produce halos). We begin this chapter
with a brief overview of the shell model presented in Section 12.9. Recall how electrons are arranged around an atomic nucleus. Will a lighter-than-air balloon rise indefinitely? Baking soda is an ionic compound, and it is needed in this activity to help the electrons flow through the hot solution. The ion-dipole attraction is stronger. You can use the
periodic table as a quick reference when determining the type of ion an atom tends to form. A pair of waterfilled caissons are connected on opposite sides of a 35-m-tall wheel. Note that the superclusters are strung together as though on the surface of a foam. If the timing is right and the combined mass is greater than critical, a violent explosion
takes place. History shows that the rate of production of a nonrenewable resource rises and falls in a nearly symmetric manner, as shown in (c). When heat is added to an air mass, the air pressure increases, or both increase. (Do not take this term literally, however, because in Chapter 18 you'll see that under the right
conditions, even "nonbonding" pairs can form a chemical bond.) Valence electrons that are unpaired, by contrast, have a strong tendency to participate in chemical bonding. The focus is the point where the rock actually breaks. FIGURE 15.31 Oil and water are difficult to mix, as is evident from this oil spill off the coast of Spain in 2002. CHECKPOINT
According to the aqueous solutions illustrated here, which is the stronger base: NH3 or NaOH? FYI 524 PA R T H R E E E A R T H R E E E A R T H R E E E A R T H R E E E A R T H R E E E A
cataloged as M104, is about 80,000 light-years in diameter and about 32 million light-years from Earth. Low-density polyethylene (LDPE), shown in Figure 19.27b, is made of strands of highly branched chains, an architecture that prevents the strands from packing closely together. Carbon dioxide is absorbed and released. Corrosion caused by
atmospheric oxygen is a widespread and costly problem. Crystallization in Magma Magma is composed primarily of the elements found in the silicate group of minerals—namely, silicon and oxygen, plus aluminum, potassium, sodium, calcium, iron, and magnesium. It can be at rest or moving uniformly in a straight line. Give an explanation in terms of minerals—namely, silicon and oxygen, plus aluminum, potassium, sodium, calcium, iron, and magnesium. It can be at rest or moving uniformly in a straight line.
thermal expansion. C H A P T E R 10 REVIEW 263 R E A D I N E S S A S S U R A N C E T E S T ( R AT ) If you have a good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. What feature helps distinguish schist and gneiss from quartzite and marble? Each gray arrow shows an alpha decay, and
each red arrow shows a beta decay. The sodium chloride, NaCl, shown in Figure 14.16 is very different from the elemental sodium and the elemental 
ion concentration is equal to the hydroxide-ion concentration. If the Moon's tangential velocity were zero, how would it move? This lost mass is multiplied by the speed of light squared (c 2 in Einstein's equation), the
product is equal to the energy yielded by each uranium nucleus as it undergoes fission. Domains in the paper clip are induced into alignment in a manner similar to the electric charge polarization in an insulator when a charged object is brought nearby. Energy would be released from the fissioning of gold and from the fusion of carbon, but by neither
fission nor fusion for iron. As the upper-level air rises, surface air is sucked upward, intensifying the low-pressure center—the eye of the hurricane. Try experimenting with tubes of different lengths. In fact, at that time, James Clerk Maxwell was the only person in the entire world to know that light of any kind is energy carried in waves of electric and
magnetic fields that continually regenerate each other. Why don't all collisions between reactant molecules lead to product formation? Superposition In an undeformed sequence of sedimentary rocks, each bed or layer is older than the one above and younger than the one below. The dry conveyor belt originates to the west of the storm, in the upper
troposphere. A gecko's feet are covered with billions of micro1 as thick as a human hair. 3.5 Work-Energy Theorem 19. (d) The boiling process removes the air that was dissolved in the water. Purchase some sodium-free salt, which is potassium chloride, KCl, and examine these ionic crystals, both intact and crushed. In addition, because carbon-
fluorine bonds are unusually strong, Teflon can be heated to high temperatures before decomposing. Such an interval is called the doubling time. (c) No external force acts on the cue-ball + eight-ball system, and momentum is conserved (simply transferred from one part of the system to the other). A similar thing happens to the molecules of a solid
 when it is heated. 474 Reduction PA R T T W O CH E M I S T RY 2 NH4 \leq 20 NH3 \leq 12 NH3 \leq 12 NH3 \leq 12 NH3 \leq 13 NH3 \leq 14 NH3 \leq 15 NH3 \leq 15 NH3 \leq 15 NH3 \leq 16 NH3 \leq 16 NH3 \leq 17 NH3 \leq 18 N
(cm3) or cubic meters (m3).* A gram of any material has the same mass as 1 cm3 of water at a temperature of 4°C. The result is a net movement of fresh water into the body of salt water, as illustrated in Figure 16.32. After about 10 minutes, reexamine the contrails. After a star has used all its nuclear fuel, its outer layers escape into space, leaving
the dense core behind as a white dwarf. A meteor is visible only once, but a comet may be visible at regular intervals throughout its lifetime. Does a fast-moving baseball possess force? With this in mind, next time you see the crescent Moon close to the horizon, look carefully at its angle and try correlating that angle to your local latitude. Two colors
that add to produce white are called complementary colors. CHAPTER 18 1. The structures in Figure 19.2, for example, are different conformations of pentane. If you score less than 7, you need to study further. The best pool tables and chalkboards are made from slate quarried in metamorphic areas where slaty cleavage is well developed
CHECKPOINT Is recrystallization, due to elevated temperature and pressure, the opposite of partial melting? Condensation polymer A polymer formed by the joining together of monomer units accompanied by the loss of small molecules, such as water. If favorable conditions continue, a more violent storm develops—a hurricane—with wind speeds
above 120 km/h and up to nearly 300 km/h. What if, in 1942, the Earth had been 9 billion years old? Similarly, an electric charge on a single electron. When accumulation exceeds ablation, the glacier advances—it grows. At the atomic level, what is meant by saying
something is electrically charged? (a) carbon chloride (b) dichlorocalcium (c) calc two (d) dicalcium chloride (e) calcium chloride (n) a source of cooling doesn't apply, however, to objects that contain a source of
energy, such as a running engine or a radioactive source. If someone shone a flashlight on a ball in a dark room, you could tell where the flashlight was by looking at the illumination on the ball. The road simultaneously pushes forward on the tires (reaction). Second, look to the north (close to where the Big Dipper is often seen) to find the letter "W,"
which is the Cassiopeia constellation. Mass number of nucleons in an isotope. The rising vapors contain only the volatile components of the mixture. There are eight isoprene units needed to make a single beta-carotene molecule. Why does a bimetallic strip bend with changes in temperature? The current thinking of most
cosmologists, therefore, is that our flat universe is destined for an eternal expansion. As the two metals make contact on the wet surface of your tongue, you will be able to sense a small tingling, warming sensation. 10.9 Bow Waves and the Sonic Boom EXPLAIN THIS How can a snapped circus whip produce a sonic boom? A 1-m-tall barrel is closed
on top except for a thin pipe extending 5 m up from the top. Inside a baseball, trillions of interatomic forces are at play. Lighter Kuiper belt objects, however, are thrown off course quite frequently. Mercury's atmosphere—it's a better vacuum than laboratories on Earth can produce. 9.3
Magnetic Domains 6. Why does the pupil of the eye appear black? K 18 He. H. When a rock with both quartz and feldspar melts, the quartz is pure silica!). Note the shadows cast by the ball. 10 Field Induction magnet attracts nails but also how nails stuck
to her magnet attract nails that dangle below it. The law of reflection holds locally at each tiny part of the irregular surface, but not for the diffuse surface as a whole. Transform plate boundary where two plates are sliding horizontally past each other, without appreciable vertical movement. You've got only four choices: ion-dipole,
dipole-dipole, dipole- induced dipole- induced
mouth of a drinking glass. Mass density is mass per volume; weight density is mass per volume, a straight-line path relative to both an observer outside the spaceship and a stationary observer outside the spaceship and a stationary observer outside the spaceship. Polar molecules may be attracted to the ionic heads of the fatty acid, but they have a hard time passing by the nonpolar
tails. Why will attraction also occur if you place the same iron near the south pole of the magnet? If a white dwarf is a binary and close enough to its partner, the white dwarf may gravitationally pull hydrogen from its companion star. T H I N K A N D R A N K (A N A LY S I S) 54. These are evaporation ponds, where the water is allowed to evaporate,
leaving behind the solids that were dissolved in the seawater. Air molecules stuck inside an inflated balloon collide continuously with the inner surface of the balloon. In this way, the resin exchanges ions, ature of an air parcel decreases when lifted? For magma, this doesn't easily happen, because the particles are strongly attracted to one another.
The P-wave shadow between 105° and 140° from an earthquake's epicenter is caused by the refraction of the P-waves at the core-mantle boundary. Does this mean the net force is zero? When there is no beat frequency, the frequency, the frequency the frequency the frequency that the core-mantle boundary.
(and other places) from west to east. The frequency of this radiation is proportional to the absolute temperature of the emitter. But if the resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current, and R for resistance is Amperes = * Many texts use V as the symbol for voltage, I for current is Amperes = * M
hitting force is large. This is a chemical change because iron and rust are two different materials, each consisting of a different arrangement of atoms. If air resistance is negligible, predict which ball will hit the ground below with greater speed. CHAPTER 9 M AG N E T I S M A N D E L E C T R O M AG N E
TICINDUCTION 23 Magnetic Force on Current-Carrying Wires Simple logic tells you that if a charged particles moving through a magnetic field also experiences a deflecting force. What does sulfur dioxide have to do with acid rain? See also
Rock(s) in chemical sediments, 532 classification, 528-529 cleavage of, 526-527 color of, 524-528 formation of, 520-533 fracture of, 527 crystallization of, 520-533 fracture of, 527 crystallization of, 520-533 fracture of, 526 in magma, 530-533 fracture of, 527 crystallization of, 527 crystallization of, 528-529 cleavage of, 526-527 color of, 527 crystallization of, 528-529 cleavage of, 526 in magma, 530-533 fracture of, 527 crystallization of, 527 crystallization of, 528-529 cleavage of, 526 in magma, 530-533 fracture of, 528-529 cleavage of, 528-5
silicate, 528 solubility of, 532 in water solutions, 532-533 Mixtures, 398-426 heterogeneous, 400 homogeneous, 400 homogeneou
T W O CH E M I S T RY Paper chromatography was originally developed to separate plant pigments from one another. Bleier/Photolibrary/Peter Arnold, Inc. Average Speed In planning a trip by car, the driver often wants to know the travel time. That's why a burn from 100°C steam is much more damaging than a burn from 100°C boiling water
Rather, they cause skin oils to transform into slippery solutions of soap. Hewitt 235: Paul G. (a) (b) (e) (c) F I G U R E 11. This is a nice procedure for transferring liquids from one test tube to another. CHECKPOINT A hot pizza put outside on a winter day is a net emitter. After driving a turbine, it is recirculated into the hot cavity again, making a turbine, it is recirculated into the hot cavity again, making a turbine, it is recirculated into the hot cavity again.
closed cycle. Discuss your understanding of and thoughts on the potential fates of the universe as described in Section 28.6. For more background, review the references in Table 28.1. R E A D I N E S S A S S U R A N C E T E S T (R AT) If you have a good handle on this chapter, if you really do, then you should be able to score 7 out of 10 on this
RAT. There are two force pairs to consider: the fan-air force pair and the air-sail force pair are water? Judy (mass 40 kg), standing on slippery ice, catches her dog Atti (mass 15 kg) leaping toward her at 3.0 m/s. (b) gradually turn into a cosmological blueshift. 13.4 Radiometric Dating How does
radioactivity allow archeologists to measure the age of ancient artifacts? Analogously, think of what happens when you try to submerge a flotation device, which is less dense than water, in a swimming pool. Copper atoms have a greater tendency to be reduced than iron atoms do. Some minerals show a greater tendency toward cleavage than others.
b, a, c. If light of low frequencies were scattered, the noontime sky would appear reddish orange. Break the pieces in half again, and you have four complete magnets. What is the Kuiper belt? REVIEW 113 33. Don't we, in the same way, tend to exaggerate the differences on the surface while ignoring the similarities and subtle differences within?
When you push against a wall with your fingers, they bend because they experience a force. The rate of transferring energy is power. block, the fracture is called a fault. This photo was taken by the Messenger spacecraft, which was launched from Earth in 2004 and reached orbit around planet Mercury in 2011. 2 7 The beautiful barred spiral galaxy
NGC 1300 is about 100,000 lightyears across and some 70 million light-years away. LEARNING OBJECTIVE Describe how forces always occur in pairs. Tap the tongs or pliers on the bowl's edge to cause the molten zinc to drip into the bowl. By exerting a small force through a large distance, she can provide a large force that acts through a small
distance. Although the iceberg has less thermal energy per mass, its enormously greater mass gives it a greater total amount of energy than that in the small cup of coffee. If bulb A is unscrewed, the top branch is no longer part of the circuit and current ceases in both bulbs A and B. The speed at any instant is the instantaneous speed. Sucrose
molecules, therefore, can form multiple hydrogen bonds with one another. (b) kinetic energy. In the hydraulic pistons shown in the sketch, the small piston has a diameter of 2 cm. FIGURE 9.36 Electric field INTERACTIVE FIGURE 5.36 Electric field INTERACTIVE 5.36 Electric field INTERACTIVE FIGURE 5.36 Electric field INTERACTIVE 5.36 Electric field INTE
direction of motion of the wave. We can detect dark matter by its gravitational effects. Sodium chloride Lithium oxide Calcium fluoride HCl MgO Sr3P2 Hydrogen chloride Magnesium oxide Strontium phosphide GUIDELINE 2 When two or more compounds have different numbers of the same elements, prefixes are added to remove the ambiguity.
Small samples of oxygen gas needed in the laboratory can be generated by a number of simple chemical reactions, such as 2 KClO3(s) h 2 KCl(s) + 3 O2(g) According to this balanced chemical equation, how many moles of oxygen gas are produced from the reaction of 2 moles of KClO3 solid? Figure 26.26 shows that at noontime, you would be on the
wrong side of Earth to view the full Moon. (b) An atom is invisible because it is smaller than the wavelengths of visible light toward our eyes. In . 5 Nuclear Fission 13. Figure fluorescent lamp (CFL) read "13 W 8.34 shows a compact fluorescent lamp (CFL) that fits into a standard lightbulb socket. For the jet: a
= = 2 m/s2. When we see the vibrations of the "ringing" bell in a vacuum, we know that light can pass through a vacuum, we know that the secondary coil should have 18 turns. Why do we say that velocity is a vector and speed is not? See also Minerals; Rock(s) Geothermal energy, 81 Giant stars, 743
Glacial mass balance, 610-611 Global circulation, 608-609 Glaciers, 608-614 erosion and, 611-612 formation of, 608-609 movement of, 609 sedimentation and, 613-614 Global circulation patterns, 670-677 oceanic, 672-677 upper atmospheric, 671 Global warming, 172-173, 664-666 Gneiss, 547-548 Gondwanaland, 631-632, 633 breakup of, 635-636
Grams-moles conversion, 432-434 Granite, 536 Gravity, 90-118 acceleration and, 778 inverse-square law and, 93-94 projectiles and. Assume the Milky Way contains 100 billion stars evenly distributed with none concentrated toward the center. Mixtures Can Be Separated by Physical Means FIGURE 16.3 Most of the oxygen in the air bubbles
produced by an aquarium aerator escapes into the atmosphere. We can extend the idea of a cannon recoiling from the ball it fires to understanding rocket propulsion. So the answer depends on how you look at it. A poorly sorted deposit contains particles of many different shapes and sizes. 2 2 9 0. By Newton's second law, a = mg - R Fnet = m m
where mg is her weight and R is the air resistance she encounters. As mentioned earlier, think before you read the answers. (c) In a headwind that matches the air speed, the plane would "hover" above the ground as it touches down! So its landing speed is zero. (c) (d) Examples of fossilization. In Earth's interior, what two factors increase with depth?
Why, then, doesn't the double brick fall twice as fast (as Aristotle supposed it would)? FYI 202 PARTONEPHYSICS INJURY BY ELECTRIC SHOCK Many people are killed each year by current from common 120-V electric circuits. Shake flashlights need no batteries. Consider the bug in our previous example. The opposite end, called the south-
seeking pole, points southward. We say almost because some energy goes into heating the ground and ram during penetration. Sooner or later, mistakes (and deception) are found out; wishful thinking is exposed. Interestingly, the deeper you go below Earth's surface, the hotter it gets. 28.6 The Fate of the Universe EXPLAIN THIS When should
speculations be discounted? What effect might their longevity have on social reforms, such as civil rights? The electrons lost by one chemical in a reduction reaction don't simply disappear; they are gained by another chemical in an oxidation reaction don't simply disappear; they are gained by another chemical in an oxidation reaction don't simply disappear; they are gained by another chemical in a reduction reaction.
following reasoning is wrong. The Big Bang answers another cosmic mystery involving the element helium. A hydrocarbon must have at least one multiple (double or triple) bond to be unsaturated. This There are always two electrons per covalent bond. (a) Permineralization occurs when mineralization occurs when mineraliz
petrified wood. If the bag is airtight, then whatever air is inside the bag when it is on the ground expands against the decreased cabin pressure when the plane is aloft. Polar ice is one possible answer. 9 INTERACTIVE FIGURE Reactants coming together. LEARNING OBJECTIVE Describe the discovery of galaxies; their classification as elliptical,
spiral, or irregular; and how they are organized into superclusters. The slowness of the fall is due to the interaction of the magnetic field of the falling magnet with the field induced in the conducting tube. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 13.1 Radioactivity 1. Neptune's orbit typical Kuiper belt comet orbit Kuiper belt:
• Extends from about 30-50 AU • Contains about 100,000 Oort cloud: • Extends out to about 50,000 AU • Contains about a trillion objects • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets more than 100 km across • Comet orbits have random tilts and very large eccentricities comets and the comet orbits have random tilts and very large eccentricities comets and the comet orbits have random tilts and very large eccentricities comets and the comet orbits have random tilts and very large eccentricities comet orbits have random tilts and very large eccentricities comet orbits have random tilts and very large eccentricities comet orbits have random tilts and very large eccentricities comet orbits have random tilts and very large eccentricities comet orbits have random tilts and very large eccentricities comet orbits have random tillustration to the comet orbits have random tillustration to the 
whipped around the planet and then flung violently outward in some direction. Over geologic time, the various plates have pulled apart, crashed, merged, and separated from one another. 4 3 9 16 5 FIGURE A.2 If the ball covers 1 m during its first second, then in each successive second it will cover the odd-numbered sequence of 3, 5, 7, 9 m, and so
on. (4) Metamorphism converts bituminous coal to anthracite, a hard, black, high-energy coal. Acid-base reactions involve the transfer of protons from one reactant to another. Hydrogen sulfide, H2S, is one of the smelliest compounds. SAM PLE PROBLEM 5 What is the pH of a solution with a hydronium-ion concentration of 10-9 M? 3.00 * 108 m/s c
43. Perhaps a force that keeps the children together is their mutual attraction to the toys they share. In this chapter we will explore the nature of stars—how they form, how they die, and how they are organized within galaxies. But two hair dryers on the same circuit will blow the fuse. When the electronegativities of the atoms differ, a dipole may
form (as with HF) and the bond is classified as a polar bond. This improvement, however, has been offset by an increase in the number of cars being driven, CO as exemplified by the traffic jam shown in Hydrocarbon Figure 17.16. The apparent path of polar wandering as determined from North American rocks is different from the path determined
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from European rocks. For this reason, many iron objects, such as the nail pictured in Figure 18.33, are galvanized by coating them with a thin layer of zinc. And all objects, whether at rest or moving, have an energy of being—E = mc 2. If it's done the other way around, the glasses will stick even tighter (if not break). How many types of atoms can you
expect to find in a pure sample of any element? These rocks and minerals form Earth's crust, mantle, and core. E X E R C I S E S (SYNTHESIS) 39. Does Archimedes' principle tell us that if an immersed block displaces 10 N of fluid, the buoyant force on the block is 10 N? A saturated solution of sodium nitrate, NaNO3, is more concentrated than a
saturated solution of sodium chloride, NaCl. 57. How many electrons does this iron atom have? Neither, because iron is at the very bottom of the "energy valley." Fusing a pair of iron nuclei produces an element to the right of iron on the curve, where mass per nucleon is higher. You provide an impulse to reduce its momentum to zero. (b) v = d 2y Bg
= 12.0 m 2(1.00 m) B 10 m/s2 = 26.8 m/s \ 27 m/s (c) We can see that the mass of the ball (in both problems) doesn't show up in the equations for motion, which tells us that mass is irrelevant. High-temperature objects radiate short waves; low-temperature objects radiate short waves; low-temperature objects radiate short waves.
an isotope of lead, is shown in Figure 13.17. Unless, of course, it was during a spectacular solar eclipse. This illustrates the principle of cross-cutting relationships. 18.8 Corrosion and Combustion EXPLAIN THIS Do our bodies gradually oxidize or reduce the food molecules 479 Our bodies require lots of energy for living. So why, then, was the damage
from these two earthquakes so different? (d) NF. Which move faster: Saturn's inner rings? You toss a tennis ball up and down in front of you as you sit in a jet airplane cruising at a constant speed of 500 mph. (Innumerable layers of drops form innumerable two-dimensional arcs, like the four sets suggested here.) VIDEO: The
Rainbow F I G U R E 11. What are two ways in which people disinfect water in areas where municipal treatment facilities are not available? 1.0012 3 1.0010 Volume (mL) Between 0°C and 4°C, the volume of liquid water decreases as temperature increases. Why does the act of striking magnetize the nail? 1 Momentum and Impulse 3. Does your
answer change if the ice cube contains many air bubbles? What is a physical property? 12.2 The Elements EXPLAIN THIS Why isn't water an element? The number of induced dipole attractions between these two molecules is therefore greater. The air we exhale is a gaseous solution of 75% nitrogen, 14% oxygen, 5% carbon dioxide
and around 6% water vapor. Even when you think you're standing still, you're actually speeding through space. In each case she attains equilibrium (no acceleration). • Also new to this edition, the solutions to the odd-numbered end-ofchapter questions are provided in the back of this book. FYI If the seafloors spread, continents must move.
Alternatively, they may be single-cell organisms, such as bacteria. What single color of light illuminating a ripe banana will make it appear black? Giants do have a relatively low energy output per unit surface area; they are highly luminous only because they are very large. Constant speed implies that the net force on the cabinet is zero. Most are
invisible, but they act as tiny centers to which other particles adhere. The batons are water molecules made to rotate to and fro in rhythm with microwaves in the enclosure. (d) The corrosive properties are neutralized by the salt. 1 Seismic Waves 21. With greater amounts of solar energy at the tropics, one would expect evaporation to exceed
precipitation and cause an increase in salinity. The angles of incidence and refraction are in accord with Snell's law (see footnote on page 273). Another part supports life in the food chain that begins with plants (and other photosynthesizers), and part of this energy later is stored in oil. (You should know that wastewater treatment experts point out
that these insolubles—even cooking grease—should be disposed of as solid waste and not washed down the treatment is primary treatment. REVIEW 487 80. C H A P T E R 17 H O W CH EM I C A L S R E AC T 437 F I G U R E 17. The horizontal component of a
projectile's motion is just like the bowling ball's motion along the lane. (b) If the speed is 3.5 m/s and the coffee table is 0.4 m tall, show that the distance the coin lands from the base of the table is 1.0 m. Unlike the harmonics of woodwinds and brasses, stringed instruments, such as the piano, produce "stretched" partial tones that are nearly, but not
quite, harmonics. When the egg strikes the wall, the impact time is short and the impact force is correspondingly large; the egg breaks. From Problem 39 you are given that 63,000 AU equal about 1.0 lightyear. Significant progress, however, has been made toward fixing the problem. Show that its speed 1 s later is 14.1 m/s. 7.6 Heat Transfer and
Change of Phase EXPLAIN THIS How does a tub of water freezing in a small room change air temperature? Rain is but one form of precipitation. The 21st century will likely see a switch from fossil fuels to more sustainable energy sources. With an alkaline solution, the dye can penetrate through the cuticles into the hair for a more permanent effect.
The distance term d in Newton's equation is the distance between the centers of masses of the objects. a, 6. The debris soon collected as a ring around Earth, and then, within about 1000 years, the ring coalesced into the Moon. The probe moves of its own inertia. For now, you should understand that the hydronium and carbonate ions are examples of
polyatomic ions, which are molecules that carry a net electric charge. When atmospheric CO2 dissolves in any body of water—a raindrop, a lake, or the mass of the reactants (16 g + ? Mass can transform into energy and energy can transform into mass
in accordance with Einstein's equation E = mc 2. Hot coffee poured into a saucer cools because (1) the greater surface area of the coffee permits more evaporation to take place, and (2) by the conservation of energy, the thermal energy that heats up the saucer comes from the coffee, cooling it. ether 2. Coal-fired power plants are as American as
apple pie, with no required (and expensive) shielding to restrict the emissions of radioactive particles. The waves overlap to produce a barrier of compressed air on the leading edges of the wings and on other parts of the aircraft. Which element in the periodic table has the greatest electronegativity? Graphs that indicate the varying pressure of the
air on the eardrum are shown in Figure 10.41. Pb2+ O O - - O O HO N O N O OH 63. Faster seafloor spreading means warmer and hence less ocean crust. If vertical alignment nicely remains as they fall to the floor, you'll see that the small ball bounces unusually high. CHECKPOINT Whoa! We learned previously that the pull of gravity is an
interaction between masses. Which fizzes more in your mouth? 14 7 n 14 6 N 1 1 C H This carbon-14 isotope, which makes up less than one-millionth of 1% of the carbon in the atmosphere, is radioactive and has eight neutrons. Scientists have agreed to identify elements by atomic number, which is the number of protons each atom of a given element
contains. A farmer turns on the propane burner in his barn on a cold morning and heats the air to 20°C (68°F). The rate of cooling depends on how much hotter the object is than its surroundings. Answer the same question for an iron block. A nyone who has played around with magnets knows that magnets exert forces on one another. Why don't we
see the bird's feet in the reflection? He proposed that the boundary of each continent was not at its shoreline and the steep slope that leads to the deep ocean floor). Recall the Doppler effect, discussed in Chapter 10. To understand and predict the weather, we
must understand all three. These two factors combined to make the Sun-facing side of Venus significantly warmer than Earth. In a mass spectrometer, ions are directed into a magnetic field, where they curve around in the field and strike a detector. Only the water flows, not the pressure. D I S C U S S I O N Q U E S T I O N S (E VA LUAT I O N) 89.
Another friend disputes this claim and states that all bullets from any rifle drop beneath a straight-line path a vertical distance given by 1 2 2 gt as soon as they leave the barrel and that the curved path is apparent for low velocities and less apparent for low velocities. Most of the helium on Earth arises from the radioactive decay of heavy isotopes, as
was discussed in Chapter 13. The best viewing times in the Northern Hemisphere are during the late fall, early winter months. Turbulent flow Water flowing rapidly and erratically in a jumbled manner, stirring up everything it touches. Von Guericke placed together two copper hemispheres about 0.5 m in diameter to form a sphere, as shown in
Figure 5.20. If you look out an airplane window and view another plane flying at the same speed in the opposite direction, you'll see it flying twice as fast—nicely illustrating relative motion. The water in the melon has more "thermal inertia"—a higher specific heat capacity—than sandwich ingredients. They are almost always made up of water
droplets, but, in cold weather, they may also contain ice crystals and snow. Solution: Multiply the solution concentration by the final volume of the solution concentration by the final volume of the solution. That's what many practitioners of junk science offer. How readily an acid donates a hydrogen ion is a function of how well the acid is able to accommodate the resulting negative charge it gains and snow.
after donating. 98 PARTONEPHYSICS Velocity of stone's velocity FIGURE 4.1 3 Vertical and horizontal component of stone's velocity FIGURE 4.1 3 Vertical and horizontal component of stone's velocity FIGURE 4.1 3 Vertical and horizontal component of stone's velocity FIGURE 4.1 3 Vertical and horizontal component of stone's velocity FIGURE 4.1 3 Vertical and horizontal component of stone's velocity FIGURE 4.1 3 Vertical and horizontal component of stone vertical component of st
each, the fourth and fifth shells 18 each, and the sixth and seventh shells 32 each. Could they drink a soda this way on the Moon? What is the relationship between the Sun and Mercury vary? As the universe expands exponentially, clusters
of galaxies will be pulled farther apart, past the point of being visible to each other. In what year did Einstein publish his general theory of relativity? Fill the pot halfway with water and bring the water to a boil. Whereas water in a lake has the same density at any level (assuming constant temperature), the density of air in the atmosphere decreases
with altitude. C3H8 + 5 O2 h 3 CO2 + 4 H2O 76. (Why do your answers differ?) 65. Ursa Major, the Great Bear. When two different air masses are not strong enough to overtake each other, the boundary between them becomes a stationary front. Nothing is gained. Acceleration terminates—it
no longer occurs. For fun, carbonators can also be installed so that you can have your very own soda fountain, as shown in Figure 16.35. Corrosion is thus accelerated at the interface of these two metals. So the initially spherical nebula progressed to a spinning disk, the center of which became the protosun. This follows from Ohm's law expressed in
the form V = IR. For example, what would we think if we saw smoke moving into a smokestack? In practical terms, the density of a mineral feels for its size. Then the other colors are scattered in order: blue, green, yellow, orange, and red. Earthquakes can cause general property damage, lack of basic necessities, collapse
of buildings, loss of life, higher insurance premiums, disease, landslides and avalanches, road and bridge damage, and fires generated by broken gas and electric lines. FIGURE 14.9 INTERACTIVE FIGURE Oxygen Water Carbon dioxide Methane Chemical properties characterize the ability of a substance to react with other substances or to transform
from one substance to another. Because atmospheric pressure at Earth's surface is nearly constant, the pressure differences you feel under water depend only on changes in depth. After construction at the chosen site in Cadarache, France, the first sustainable fusion reaction may begin as early as 2015 (Figure 13.35). (There is resistance in a battery
also, which we assume is negligible here.) As lamps are introduced, more paths are available between the battery terminals, which effectively decreases total circuit resistance. When rocks on opposite sides of a fault become stuck and locked into position, the locked-up rock stores elastic energy. In a uniformly rotating giant wheel, inhabitants could
feel normal g on the inner rim, provided the rotational speed was correct for the radial distance of the wheel. Calculated radii of event horizon is not a physical surface. An ice sailcraft is stalled on a frozen lake on a windless day. How does the electric field strength
compare at a distance of 2 m from the point charge? The net force on the ball is the combination of all these forces. Note that in circular orbit, the speed of a satellite is not changed by gravity; only the direction changes. Can you infer from this information that elemental sulfur, S8, is just as smelly? Water molecules separate into a gas at 100°C.
moving charge produces a magnetic field. (b) It gives the water a fresh taste. N... MIX TURES 401 FIGURE 16.9 The path of light becomes visible when the light passes through a suspension. Cold front Frontal Lifting In weather reports, we often hear about fronts. Ionosphere An electrified region within the thermosphere and uppermost mesosphere
where fairly large concentrations of ions and free electrons exist. For example, the greatly respected Greek philosopher * We distinguish between the mathematical structure of science and the practice of mathematical problem solving—the focus of most nonconceptual courses. Molten magma that moves upward from inside Earth and flows onto the
surface is called lava. Though all stars are born in the same way from contracting nebulae, they do not all progress through their lives in the concentration of hydroxide ions is 1.0: 10 n 3 M? In any event, Newton had the insight to see that the force between Earth and a falling
apple is the same force that pulls the Moon in an orbital path around Earth, a path similar to a planet's path around the Sun. Since then, it is customary to order troops to "break step" when crossing bridges. Think of the water molecules as tiny billiard balls, moving helter-skelter, continually bumping into one another. Elliptical and/or spiral galaxies
sometimes cross paths or even collide. Energy is released as light nuclei combine. Water, H2O, for example, is made from the combination of hydrogen and oxygen atoms. What is the major difference between the terrestrial and jovian planets? Radiation intensity 15,000 K star 108 3000 K star 108 100 101 102 103 104 Wavelength (nm)
Ultraviolet Infrared 105 CHAP TER 27 S TA R S A N D G A L A X I E S 743 Notice also from Figure 27.9 that the hotter a star is, the more radiant energy it emits. So keep yours at about half charge in a cool or cold environment to extend battery life. Is momentum conserved? Instead, focus on understanding what they mean. Why is ordinary air a poor
idea? Then apply artificial respiration. Show that the water pressure in the basement is nearly 200 kPa greater than the water pressure on the top floor. Galileo found that moving things, once moving, continued in motion without the application of forces. Since all the heavy elements are manufactured in supernovae, the newer the star, the greater
percentage of heavy elements available for its construction. After this additional electron is gained, the fluorine atom achieves a filled valence shell. Heat from the room, for example, will never spontaneously move into a pan to heat it up. "She moves at constant velocity." Motion Is Relative Everything is always moving. Thorium-234, the product of
this reaction, is also radioactive. As muzzle velocity is increased, the ellipses are less eccentric (more nearly circular); and, when muzzle velocity reaches 8 km/s, the ellipse rounds into a circle and does not intercept Earth's surEarth's face. Will this dissipated energy reconcentrate itself to push him back through the air to the diving platform?
Superconductors (see Chapter 8) have the interesting property of expelling magnetic fields. The remainder is applied in thrust reversers used to slow jet planes after they land.) 115. The book falls faster because of its greater
weight compared to the air resistance it encounters. We always see the same face of the Moon on its axis matches the rotation of the Moon on its axis matches the rate at which it revolves around Earth. The basic design consists of a zinc cup filled with a thick paste of ammonium chloride, NH4Cl; zinc chloride, ZnCl2; and manganese dioxide, MnO2. Magnetic
compression further heats the plasma to fusion temperatures. Madison pushes with a 160-N horizontal force on a 20-kg crate of coffee resting on a warehouse floor. Anyone who thinks of science and technology as "inhuman" fails to grasp the ways in which they make our lives more human. The potassium atom, however, is larger because it contains
an additional shell of electrons. Hewitt 449: (right) John Suchocki/Paul G. The measured orbital speeds of stars, however, tell us that the bulk of the galaxy's mass lies outside the galaxy itself within a diffuse yet massive invisible halo many times the diameter of the visible galaxy, as shown in Figure 28.17. Power is the amount of work done per time it
takes to do it. If you forget to take keys out of your pocket as you pass through the detector, or if you wear a pacemaker, why is an alarm sounded? Science is a system by which we discover and record physical phenomena and think about possible explanations for such phenomena. That's why many physical science texts are treated as applied
mathematics. This is perhaps the most important graph in this book, for it is the key to understanding the energy associated with nuclear processes. When your eye is located between the Sun (not shown, off to the left) and the water-drop region.
The laws of thermodynamics can be stated this way: You can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you put into it), and you can't get any more energy out of a system than you can't get any more energy out of a system than you can't get any more energy out of a system than you can't get any more energy out a
its electrical needs while producing drinking water for the astronauts. One person who took this observation seriously was German naturalist Alfred Wegener (Figure 21.11). But you don't have forever, and you soon grow tired of watching the ultraslow clock as it creeps ever so slowly toward the black hole. All major objects of the solar system orbit
roughly within this same plane. A ball rolls down a curved ramp as shown. Some irregular galaxies, such as NGC 4038 shown in Figure 27.30, are the aftermaths of galactic collisions. The consequences of unchecked exponential growth are staggering. (On a winter day, you are comfortable inside your home or classroom only if the walls are warm—
not just the air.) Reflection of Radiant Energy F I G U R E 7.1 7 Radiation that enters the opening has little chance of leaving because most of it is absorbed. Identify the action and reaction forces for the case of an object in free fall (no air resistance). The alternating field induces ac voltage in the secondary. This sudden change is rarely the case, for
the rate of extracting the supply falls as it becomes more scarce. In accordance with Newton's third law, the forces are equal. Further increase in the size of the clusters causes them to fall as raindrops, and we have rain. F I G U R E 2 6 .1 6 metallic core ice covering Jupiter's four largest moons were discovered by Galileo, who was the first to point
the recently invented telescope toward the heavens. VIDEO: Oxygen Bubble Burst VIDEO: Fire Water Liquid water, H2O Gaseous oxygen, O2 CHEMICAL CHANGE Gaseous hydrogen gas by applying the energy of an electric current. Balance these equations: (a)
                                      P4(s) + H2(g) h PH3(g) (c) NO(g) + Cl2(g) h NOCl(g) (d)
                                                                                                                                         SiCl4(1) + Mg(s) h Si(s) + MgCl2(s) C H A P T E R 17 48. 99. the asteroid belt the Kuiper belt and the Oort cloud the asteroid belt the Kuiper belt and the Oort cloud all of them For instructor-assigned homework, go to
www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Asteroid belt A region between the orbits of Mars and Jupiter that contains small, rocky, planet-like fragments that orbit the Sun. Moon A The Moon orbits Earth in a plane tipped 5.2° relative to the plane of Earth's orbit around the Sun. Only light from card 2 reaches her eye
Your average speed in skateboarding to your friend's house is 5 m/s. Nice? As a result, most of the atmospheric carbon dioxide that enters our oceans remains there. In all fields, it is prudent to be skeptical of those who wish to credit themselves by calling upon the authority of others. Just like sound waves, the speed of seismic waves depends on the
elasticity and density of the material through which they travel. If the elevator accelerates downward, the springs inside the scale are less compressed and your weight reading is less. Once vibrating, these electrons emit their own electromagnetic waves, just as vibrating acoustical tuning forks emit sound waves. The petals absorb rather than reflect
the green light. Show that 1 mole of KClO3 contains 122.55 g. Note that water is much less attracted to 1-pentanol because most of 1-pentanol is nonpolar (its only polar portion is the OH group). For example, two structural isomers consist of the same number and same kinds of atoms, but in different configurations. Natural gas COOLER Gasoline
Fractionating tower Kerosene Pipe still Diesel Lubricants FIGURE 19.3 A schematic for the fractional distillation of petroleum into its useful hydrocarbon components. Was the Sun more massive 1000 years ago than it is today? Polyethylene is a plastic useful hydrocarbon components. Was the Sun more massive 1000 years ago than it is today? Polyethylene is a plastic useful hydrocarbon components.
place within our galaxy at a distance of about 7000 light-years from Earth. For the simplest case, in which the force as the product of the force as the product of the force and the distance through which the object is moved. Stars also appear to
undergo a yearly cycle around the Sun because of Earth's revolution about the Sun. Such minerals are called polymorphs (poly = many, morph = form) of each other. This is the cooled-off remnants of the Big Bang. This technique works because the path the tracer takes is influenced only by its physical and chemical properties, not by its radioactivity
In locations where heat from volcanic activity is near the surface and groundwater is absent, another method holds promise for producing electricity: dry-rock geothermal power (Figure 3.36). By studying what has happened in the past, will we be better prepared for the future? 111. Most notably, they are the ones that participate in chemical
bonding, as we will discuss in Chapter 15. 556 PARTHSCIENCE LEARNING OBJECTIVE Describe how seismic waves travel through Earth's interior. FYIFIGURE on paper reveal the magnetic field configurations about (a) a current-carrying wire, (b) a current-carrying loop, and (c) a coil
of loops. Pyrex glass is an exception because it is specially formulated to expand very little with increasing temperature. d, b, a, c. Note, however, that this attraction is weaker than the attraction water molecules have for themselves, which is why oil and water are immiscible and appear to repel. (b) When an external negative charge is brought
nearby to the right, as on a charged balloon, the electron cloud is distorted so that the centers of negative and positive charge no longer coincide. Electric field Defined as force per unit charge, it can be considered an energetic aura surrounding charge no longer coincide.
In a hybrid car, braking charges up the batteries. Matter, however, has the effect of reversing this expansion. 9 Metals are shiny because their free electrons easily vibrate to the oscillations of any incident light, reflecting most of it. The law would be written the same. Think of other examples. Calculate the number of joules of potential energy
required to elevate a 1.5-kg book 2.0 m. Literally, resonance means "resounding" or "sounding again." Putty doesn't resonate, because it isn't elastic, and a dropped handkerchief is too limp to resonate. CHAPTER 9 REVIEW 237 R E A D I N E S S A S S U R A N C E T E S T (R AT) If you have a good handle on this chapter, if you really do, then you
should be able to score at least 7 out of 10 on this RAT. Neutrons escape via the surface before a sustained chain reaction can build up. 28.5 Dark Energy 21. The atoms of the second group, including beryllium and magnesium, each have two outershell electrons. We are moving at just the proper speed so that the orbit is sustained. Entropy is a
measure of disorder. This pair of forces, your pull on the cart and th
electrical outlets, charged overnight, and driven the next day for up to 60 mi without using any gasoline. Why does your hand hurt if it is carrying a heavy load? 2 1 The Sun is truly a "hothouse"—dispersing enormous amounts of energy from exothermic nuclear reactions. Are you looking to collect your own meteorites? The satellite loses speed until
it reaches position B. Changes that result in the concentration of energy do not tend to occur—they are not directly associated with falling precipitation, they sometimes generate a light drizzle or mist. Less commonly, freezing and thawing
physically assault and disintegrate rock. Africa, Antarctica F I G U R E 2 1.1 3 Glacial striations in rock outcrops in South America, Africa, Antarctica, India, and Australia provide paleoclimate evidence that these continents were once positioned together. (b) If the ball is stopped in 0.02 s, show that the average force of
the ball on the catcher's hand is 225 N. 58. Continental polar (cP) and continental arctic (cA) air masses generally produce very cold, dry weather in winter and cool, pleasant weather in Continental summer. FYI Speed of Sound If, from a distance, we watch a person chopping wood or hammering, we can easily see that the blow occurs a noticeable
from the axis (Figure A.5). The rule is easy to remember. Interestingly, the cluster's gravity has bent the light from the quasar like a lens so that multiple images of the quasar are also seen. Incoming shortwavelength terrestrial
risk but accepting of voluntary risk? The Andes are the result of volcanic eruptions and uplift related to the subduction of the Nazca Plate beneath the South American Plate. Try this: Draw a couple of lines on a ring where you imagine a gap to be. 1.6 Support Force 15. Thus, either the magnetic pole wanders erratically or the continents have moved.
They included dozens of brilliant theoretical physicists who eventually played key roles in the development of nuclear fission. Iron makes up one-third of Earth as a whole, but most of this iron is in Earth's interior. These metals tend to be harder than the alkali metals and less reactive with water; hence they are used for structural purposes. P L U G A
emphasis on computa- tion misses something essential—comprehension—a gut feeling for the concepts. So we see an upside-down view that looks as if reflection were occurring from a water surface. (e) both a and b. If the ball is given an initial KE, it will return to its starting position with the same KE moving toward and hitting the instructor. S F I G
URE 2.14 When you lean against a wall, you exert a force on the wall. Hewitt 71: x99/x99/ZUMA Press/ Newscom 72: Paul G. 3. Different forces exerted over different time intervals can produce the same impulse: Ft t or F the wall or the haystack and coming to a stop, it takes the same impulse to decrease your momentum to zero. 6 Time Over
and boats don't tip out as the wheel makes each half revolution. Is there some angle at which there is a dead heat, where both hit at the same time? The first set contains 10 dimes and 25 pennies. Although 1 m3 of air at sea level has a mass of about 0.4 kg. and an output coil of wire (the
secondary). From where does a quasar release its energy? 7.4 Newton's Law of Cooling EXPLAIN THIS Why will a hot pizza cool quicker outside on snow than in Emission and absorption in the visible part of the spectrum are affected by color, whereas the infrared part of the spectrum is more affected by surface texture. (c) neither dc nor ac.
Northern horizon F I G U R E 2 7. This is an inelastic collision, characterized by deformation, or the generation of heat, or both. If you look at unpolarized light through a Polaroid filter, you can rotate the filter in any direction and the light appears unchanged. The descriptive names of the sections are merely a historical classification, for all waves are
the same in their basic nature, differing principally in frequency and wavelength; all of the waves have the same speed. The technology would be unbelievable to us as our present technology would be unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology would be unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology would be unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology would be unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology of 200 years from now may be just as unbelievable to us as our present technology 
spacecraft in 2015. A water skier is familiar with the fact that next to the high hump of the V-shaped bow wave is a V-shaped depression. Yes, you exert an impulse to throw a ball. When it is dissolved in acid? Gold, diamond, and water can be identified by their physical properties. At points along such regions, the waves arrive out of step. See more
about this in the readable book E = mc 2, by David Bodanis. Ethanol, C2H5OH, on the other hand, is the "alcoholic beverages, and it is one of the oldest chemicals manufactured by humans. Consider wind blowing across a peaked roof. Is this solution acidic, basic, or neutral? When white light shines through the negative, red is transmitted
where cyan is absorbed. o far, we've treated force in its simplest sense—as a push or pull. Oxygen and silicon make up more than 75% of Earth's crust. The continental crust stands higher because it is composed of buoyant granitic material. What type of cloud is above you: nimbostratus or cumulonimbus? 12.9 The Shell Model Why do elements in the
same group of the periodic table have similar properties? For comparison, a single breath of air contains about 100 times the amount of molecular oxygen found in a half-liter of "oxygenated" water. Hence, when a plastic straw is rubbed with a piece of wool, electrons transfer from the wool to the plastic straw. S TAT I C A N D CU R R E N T E L E C T
RICITY Rub a balloon on your hair, and the balloon becomes negatively charged—perhaps to several thousand yolts! That would be several thousand volts! That would be several thousand joules of energy, if the charge were 1 C. Which of these equations best explains the usefulness of automobile airbags? At sea level, atmospheric pressure is about 101 kPa. Atomic mass The mass of an
element's atoms listed in the periodic table as an average value based on the relative abundance of the element's isotopes. The light waves are stretched, which means the frequency of the light is lowered. What is the sign of charge of the particle in this case? No matter which way they directed their receiver, they detected microwaves with a
wavelength of 7.35 cm coming toward Earth. Desalination With the depletion of sources of natural fresh water in many regions, there has been growing interest in techniques for generating fresh water from Earth's far larger reserves of seawater or from brackish (moderately salty) groundwater. Because this number of grams of water is numerically
equal to the formula mass, the sample contains 6.02 * 1023 water molecules, which is 1 mole. This device is made of two strips of different metals welded together, one of brass and the other of iron. Why are objects with vast numbers of electrons normally not electrically charged? 21.5 The Theory of Plate Tectonics EXPLAIN THIS How is magma
generation related to movement of the plates? This is the principle of the transformer—a simple electromagnetic-induction device consisting of an input coil of wire (the primary) LEARNING OBJECTIVE Describe how voltage and current can be boosted or lowered. Do you see why? 7 Pascal's Principle 5. In the headlight of an automobile? In the
simplest sense, a force is a push or pull. Case 2: Decreasing Momentum Over a Long Time If you were in a truck that was out of control and you had to choose between hitting a concrete wall or a haystack, you wouldn't have to call on your knowledge of physics to make up your mind. (b) matter itself. How about your mass? How will the accelerations
of the book and paper compare? A machine is a device for multiplying forces or simply changing the direction of forces. In water that slows, pressure is higher and bubbles are squeezed to a smaller size. By the time the ratio of protons to neutrons was 7:1, the universe would have cooled enough to allow for nuclear fusion. No, no, no! When we say
boiling is a cooling process, we mean that the water left behind in the pot (and not your hands!) is being cooled relative to the higher temperature it would attain otherwise. 12.7 The Quantum Hypothesis 19. Ancient American cultures ran their lives using three calendars. The Instructor Resource DVD provides you with everything you need to prepare
for dynamic, engaging lectures in no time. A neutron star is a kilometersized atomic nucleus! F I G U R E 2 7.1 7 The pulsar in the Crab Nebula rotates like a searchlight, beaming visible light and X-rays toward Earth about 30 times per second, blinking on and off: (a) pulsar on, (b) pulsar off. Why isn't carbon-14 dating accurate for estimating the age
of materials older than 50,000 years? A firefighter of mass 80 kg slides down a vertical pole with an acceleration of 4 m/s2. Safety matches work the same way, except that the red phosphorus is embedded within the striking strip, which is the only place where the match can be lit. So don't connect a 110-V iron, toaster, or electric stove into a 220-V
change in which the atoms in a methane molecules of carbon dioxide and those in two oxygen molecules first pull apart and then form new bonds with different partners, resulting in the formation of molecules of carbon dioxide and water. Mass number is a count of the number of nucleons in an isotope. The heavyweight boxing champion of the world punches a sheet of
paper in midair, bringing it from rest up to a speed of 25.0 m/s in 0.050 s. So minerals with low melting points crystallize last. a F m=a Thus we see why the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannonball is so large compared with the change in velocity of the cannon change in velocity of the cann
burn your finger goes instead into changing the phase of the moisture on your finger. The coin continues in its horizontal motion, in accord with the law of inertia. 2.2 Newton's Second Law of Motion 6. Stars on the main sequence, including our Sun, generate energy by fusing hydrogen to helium. A TV screen is normally light gray when not
illuminated. Electricity is everywhere, including the lightning in the sky and the batteries that power your iPad. The oxygen readily picks up the electrons (in other words, the oxygen is reduced) and reacts with water to form hydroxide ions. Between ridge segments, lithosphere coming from one ridge moves in the opposite direction of lithosphere
coming from the other ridge (Figure 21.28). A common reaction is the fusion of H-2 and H-3 nuclei to become He-4 plus a neutron. Because raindrops fall faster than the updraft can push them upward, precipitation forms. We're discussing vertical motion here. Discussed further in Section 12.5, this is a nonlight imaging device that bypasses light and
optics altogether. As a result, our weather patterns are fairly consistent through the ages, which makes our planet even more favorable for the development of life. The unsaturated zone is where pore spaces are partly filled with water and partly filled with water and partly filled S-23 with air. We say, for example, that hydrogen chloride behaves as an acid when mixed with
water, which behaves as a base. So if dark matter is invisible to us, how do we know it's there? This is Bernoulli's principle again. A universe of this temperature would be expected to emit microwave radiation of just the frequency observed by Penzias and Wilson. Now close your right eye. All lamps go out. What if it were at rest in an electric field?
Internal forces and impulses won't work. The steam gives up a lot of energy when it condenses to a liquid and moistens the skin. Defend your answer using Figure 13.33. Wind keeps the air above the glass dry by blowing away moist air formed from evaporation. Electroplating is the operation of coating one metal with another by electrolysis, and it is
illustrated in Figure 18.35. Rest a part of the funnel on a nail or coin so that water can get under it. G-5 Hubble's law The farther away a galaxy is from Earth, the more rapidly it is moving away from us: v = H * d. An electric space heater dissipates 1320 W of power via electromagnetic radiation and heat when connected to 120 V. We often call this
type of condensation early-morning dew, because it occurs when daily temperatures are the coldest, just before sunrise. You stand on a weighing scale and read your weight. Under what conditions can we say that "a thermometer measures its own temperature"? The coin always keeps up with us. The tracer may be introduced alone or along with
some other chemical that helps target the tracer to a particular type of tissue in the body. Throughout his life, Wegener had a fascination with exploring the Arctic, and he was fortunate to survive several Arctic adventures. How is this analogous to the quantized energy levels of an electron in an atom? Individual atoms and nonpolar molecules, on
average, have a fairly even distribution of electrons. How does the mass per nucleon in the fission fragments of uranium? Your friend is correct; the skydiver is in fact slowing down as acceleration decreases in a dive. If bulb C is unscrewed? Although carbonates make up the bulk of chemical sediments,
evaporities are a small but important group. These rocky planets each have a mineral-containing solid crust. FYI PA R T T H R E E E A R T H S CI E N CE FIGURE 21.5 Cutaway and cross-sectional diagrams showing the change in wave paths at the major internal boundaries and the P-wave shadow. Instead, magnetic therapy is another of the untested
and unregulated "alternative therapies" given official recognition by Congress in 1992. Can metamorphic rocks exist on an island of purely volcanic eruptions of today—about 85% water vapor, 10% carbon dioxide, and 5% nitrogen, by mass. While visiting a foreign country, a
foreign-speaking citizen tries to give you verbal directions to a local museum. Oxygen and silicon dominate Earth's outer layers. I lost contact with Burl for 40 years. Hold your hand with the palm down like a flat wing outside the window of a moving automobile. As the faster-moving water molecules evaporate from the wet cloth, the temperature of
the cloth decreases and cools the metal. Hydraulics is employed by modern devices ranging from very small to enormous. So, once again, gravity plays a large role. Stand on a bathroom scale and read your weight. CHECKPOINT Which has more energy: a photon of infrared light? (The longer the half-life, the lower the
for planet B. An up-andcoming alternative to perc is supercritical carbon dioxide, CO2. Use the following balanced chemical equation to show that the products about 2.0 * 107 metric tons of carbon dioxide, CO2. Calculate where the top of the atmosphere would be.
For an orbit around the equator, these satellites remain above the same point on the ground. Wave 1 Wave 2 Wave 3 Wave 4 A 1 2 34 B FIGURE 10.30 INTERACTIVE FIGURE Water waves made by a bug swimming in still water toward point B. The water in the canteen can become a lot cooler than the outside air. When you push hard enough on the
sliding furniture to match the friction, the net force on it is zero, and it slides at constant velocity. More than 200 years later, in 1781, telescope observers added Uranus to the list of planets. chemistry, applied to Earth and its processes, make up Earth science—geology, meteorology, and oceanography. Whether a surface plays the role of net emitter
or net absorber depends on whether its temperature is above or below that of its surroundings. Any double or triple bond is often referred to as a multiple covalent bond. These key terms are now also listed in alphabetical order so that they appear as a mini-glossary for the chapter. With the rules of physics to guide them, technologists are presently
researching newer and cleaner ways to develop energy sources. Once it is in motion, you push with 60 N, which is just sufficient to keep it sliding at constant velocity. 3 O2 h 2 O3 Solution: According to the law of mass in the products must equal the amount of mass in the reactants. Then the temperature needed for
boiling rises. Thus, glass is not transparent to ultraviolet. Multiply this number by 10 (or more precisely 9.8), and you'll have your weight in newtons. Sound goes from the hermit to the mountain in 4 h and back in another 4 h to wake him. Experiment, not philosophical speculation, is the test of truth. 5 C H A P T E R 5 Fluid Mechanics L iquids and
gases have the ability 5. In the presence of hydroxide ions, the zinc oxidizes to insoluble zinc oxide: 2 MnO2(s) + 2 Cl(l) 
voltage, but they are more expensive. Although coal is composed of organic matter rather than minerals, it is considered a chemical sedimentary rock. Figure 9.13 shows a maglev train, which has no diesel or other conventional engine. Because of gravity, stream velocity tends to be greater where the gradient is steep. How would Aristotle likely
interpret this observation? The periodic table is your guide to the types of ions that atoms tend to form. Because schist rocks have large crystals, the minerals can be easy to identify. (b) not be created or destroyed. For a solar system, planets orbit as they do because most of the solar system's mass is concentrated within the central sun. Like short
pieces of Velcro, methane molecules can be pulled apart with little effort. Water molecules at the surface of ice have nothing above to cling to. Wood is a good insulator, and it is often used for cookware handles. (b) The only force acting on a satellite is gravity, so a satellite is in free fall (more about this in Chapter 4). This results in uneven heating of
the air near the ground. An object with a mass of 160 kg weighs 1600 N, or 352 lb (the weight of a large refrigerator). As discussed in Chapter 13, elements heavier than iron require the net input of energy in order to be created. Classify each of the following as a homogeneous mixture, heterogeneous mixture, element, or compound: (a) table salt, (b)
blood, (c) steel, (d) planet Earth. For example, the equation NO(g) + NO2(g) + NO2(g) (not balanced because there are one nitrogen atoms and three oxygen atoms and three oxygen atom before the arrow, but three nitrogen atoms and three oxygen atoms and three oxygen atoms and three oxygen atoms and three oxygen atoms are one nitrogen atoms.
past another with which it is in contact. b, 8. As the oxidation equation shown at the top of Figure 18.27 demonstrates, the hydrogen and hydroxide ions react to produce energetic water molecules that arise in the form of steam. In some halls, absorbers rather than reflectors are used to improve the acoustics. The bonds between the different layers
are weaker than the bonds within the individual layers. If we push a particle with twice the charge, we do twice as much work. Your hand pushes the apple upward (action), and the apple pushes your hand downward (reaction). When you step on a bathroom scale, two forces act on the scale. Does a hot object contain thermal energy, or does it contain
heat? Soap is more attracted to these ions than to its own sodium ions (with a 1 + charge). 510 PART TWO CHEMISTRY So if nothing sticks to Teflon, how is Teflon made to adhere to a pan as a coating? Use the coefficients of the balanced equation to find out how many moles of H2O are produced from this many moles of CH4: Conversion
factor 2 moles H2O (1 mole CH4)a b 1 mole CH4 = 2 moles H2O Step 3. astronomers use color to measure the temperatures of stars. The result, represented in Figure 15.33, is a solution of sodium chloride in water. Besides apparent brightness, a star's color is another property that varies widely among stars. ike light, when sound encounters a
surface, it can either be returned by the surface or continue through it. We may have already had a preview, however, when the Voyager 2 spacecraft took pictures of Neptune's moon Triton. Jogging Jake runs along a train flatcar that moves at the velocities shown. Think of the amount of force required to pull a nucleon out of the nucleus through a preview, however, when the Voyager 2 spacecraft took pictures of Neptune's moon Triton.
sufficient distance to overcome the attractive strong nuclear force, comically indicated in Figure 13.28. The crystallization points of silicate minerals strongly depend on the amount of silicate minerals strongly depend on the silicate minerals stro
The power used in the secondary is supplied by the primary. In 1855, aluminum dinnerware and other items were exhibited in Paris with the crown jewels of France. Discuss how these two facts relate to the 8-km/s speed necessary to orbit Earth. 2 C(s) + 3 H2(g) h C2H6(g) 78. F I G U R E 2 .1 0 43 44 PA R T O N E P H Y S I CS CHECKPOINT In a
vacuum, a coin and a feather fall equally, side by side. This lowers the combined resistance of the circuit. VIDEO: Interference and Beats Beats When two tones of slightly different frequencies are sounded together, a fluctuation in the loudness of the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard; the sound is loud, then faint, and so on. Show that itself the combined sounds is heard.
acceleration is 2 m/s2. How does this activity relate to the acidity of rain? F I G U R E 7.1 4 Both the Sun and Earth emit the same kind of radiant energy. (b) Aspirin, acetylsalicylic acid, is less acidic than salicylic acid because it no longer contains the acidic phenolic group, which has been converted to an ester. Whereas cork floats to the surface of
water, a released helium-filled balloon does not rise to any atmospheric surface. Then repeat this, but pucker your lips so that your mouth opening is very small. 21.1 Seismic Waves EXPLAIN THIS E How do earthquakes reveal Earth's internal composition? We learned that sound waves generated by clicking two submerged rocks together travel
faster through water than through air. See also Colors dispersion of, 282-284 Doppler effect and, 252 electromagnetic spectrum and, 265-266 opacity and, 268 polarization of, 276-277 speed of, 267 transparency and, 266-269 Lightening, 699 Light-
years, 739 Liquids. They had a good grasp of the physics of floating object. Yes, although slightly compared with its great mass. The reaction rate, therefore, can be defined either as how quickly the concentration of products increases or as how
quickly the concentration of reactants decreases. F I G U R E 3 .1 0 INTERACTIVE FIGURE The net momentum before firing is zero. The air is very hot close to the sand surface and cooler above the sand surface an
germanium, Ge; arsenic, As; antimony, Sb; and tellurium, Te. Situated between the metals and the nonmetals in the periodic table, the metallicand nonmetallic and nonmetallic characteristics. What concept of physics does this illustrate? The race thus began to squeeze more and more transistors together into tinier and tinier circuits. The water
level rises just as it would if you were adding sand. For example, on a surface of clear glass and for normal incidence (light perpendicular to the surface), only about 4% is reflected from each surface. Lightning strikes Earth roughly 100 times every second, with some bolts having an electric potential of as much as 100 million volts. CHAPTER 6 100°C
Volume = 1 + 100 273 0°C Volume = 1 - 100°C 100 273 THERMALENERGYANDTHERMODYNAMICS Volume = 1 - 273 = 0 273 - 273°C equilibrium. evaporation rate equals the condensation rate. (b) less dense. This eventually crystallizes into calcite, which then forms limestone. What function did they serve? You may
wonder why oxygen gas is not generated along with the hydrogen gas. A covalent bond, by contrast, is formed when two atoms that tend to gain electrons, fields, and motion affect force. This has major implications regarding the ultimate fate of the
universe. When galaxies were found to be receding, CHAPTER 28 REVIEW 787 many hypothesized that gravity might be strong enough to pull them back together in a Big Crunch. Meteorologists and other observers of the sky can often tell when a cold front is approaching by observing high cirrus clouds, a shift in wind direction, a drop in
temperature, and a drop in air pressure. The answer is an astounding NO! Rather, every point in the universe was present at the Big Bang. This makes for six hydrogen atoms both before and after the reaction arrow. 7. Cs. EXPLAIN THIS P Gold Opacity: opaque Color: yellowish Phase at 25°C: solid Density: 19.3 g/mL FIGURE 14.6 roperties that
describe the look or feel of a substance, such as color, hardness, density, texture, and phase, are called physical properties. Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (a) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (a) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (b) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (c) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (d) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that the kinetic energy of an 84-kg scooter moving at 2 m/s is 168 J. (e) Show that 2 m/s is 168
acceleration due to gravity is 10 m/s each second all the way down. 53 54 PA R T O N E P H Y S I CS HANDS-ON ACTIVIT Y If you drop a sheet of paper and a book side by side, the book falls faster than the paper. The electron at rest in a magnetic field be
set into motion by the magnetic field? Volume decreases as ice crystals collapse, while volume increases due to greater molecular motion. Note that sodium is oxidized when it behaves as a reducing agent—it loses electrons. (d) red giant. How exhilarating to discover connections in nature! (1 kg)(6 * 1024 kg) m1m2 37. During this galactic youth,
much material was still falling into the supermassive black holes found within their galactic cores. Instead, the stifling hot dense air sits still through its long days and nights. When the weight of ether in the head is sufficient, the bird (c) pivots forward, permitting the ether to run back to the body. An alpha particle is the combination of two protons
and two neutrons (in other words, it is the nucleus of the helium atom, atomic number 2). The compression does not change at constant velocity. The percentages, however, are quite different. Consider the open-pit copper mine shown in Figure 15.14. Marble (Figure 20.36a) is a crystalline, metamorphosed limestone. Does a good insulator prevent
heat from getting through it, or does it simply delay its passage? This is true for birds and airplanes. Both laws are inverse-square laws. Students then use what they have learned to answer multiple-choice questions based on the animations. Geologic deposits containing relatively high concentrations of metal-containing compounds are called ores. A
        peed bus and an unfortunate bug have a head-on collision. With continued inland spreading, the eastern edge of the present-day Africa (the Horn of Africa) will become a large island! FYI Oceanic-oceanic convergence occurs when two
oceanic plates meet and the older (and therefore cooler and denser) plate slides beneath the younger, lessdense plate. Metal wires across the landscape transmit communication signals and electric power. If concentration is given in grams per liter of solution, for example, the amount of solute must be in grams and the amount of solution must be in
liters. Negative acceleration is often called deceleration. Almost immediately, most of the Ping-Pong balls are energized, vibrating in all directions. r FIGURE 26.42 solar radiation solar wind Solar heating diminishes; coma and tail disappear between 3 and 5 AU from Sun. 330 PART TWO CHEMIST 
emission of a neutrino, which is a neutral particle with nearly zero mass that travels at about the speed of light. Either Venus was extra massive or some other, previously undiscovered planet was pulling on his back with a
blacksmith's anvil placed on his chest. Predictions should be consistent with the principle of energy conservation. In a balanced equation, each atom must appear on both sides of the arrow the same number of times. Actually, the angle between the incoming and outgoing rays can be anywhere between zero and about 42° (zero degrees corresponding
to a full 180-degree reversal of the liquid and up against the larger piston. That means ball B wins the race. Reacting this remaining 2 g
of carbon would require more oxygen. One rad is equal to 0.01 J of radiant energy absorbed per kilogram of tissue. Be sure the wires don't touch each other, it is a collection of sodium and chloride ions that form a unique
material with its own physical and chemical properties. Within the sixth period is a subset of 14 metallic elements (atomic numbers 58 to 71) that are quite unlike any of the other transition metals. To generate electricity without fuel, arrange a motor to run a generator that produces electricity that is stepped up with transformers so that the
generator can run the motor and simultaneously furnish electricity for other uses. Nitrogen atoms are bigger, so nitrogen atoms are bigger.
(Hint: On which track is the average speed of the ball greater? Air is driven from the can so that only water vapor molecules remain inside. How is the gold in your mother's ring evidence of ancient stars that ran through their life cycles long before the solar system came into being? All that's required is that the components have distinguishable
affinities for the moving solvent and the stationary medium, such as paper, through which the solvent will pass. This suggests that Triton is a captured object. Not only do they steal away all your potential customers, but they're so good that you end up buying bottle caps from them. (a) Wavelength = speed/ frequency = (1500 m/s)/(256 Hz) = 5.86 m.
year Put the two converted values together: 300,000 mi/h = 4.83 * 10-8 [email protected]>1.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protected]>7.14 * 10-10 yr = 4.23 * 10-10 [email protecte
The difference between 100 mm and 10 mm is 90 mm over a time of 1 s, which equals 90 mm/s, or twice the speed of 45 mm/s. Which of these equations is most useful for solving a problem that asks for the distance a fast-moving box slides across a post office floor and comes to a stop? A third way to identify a reaction as an oxidation-reduction
reaction is to see whether an element is gaining or losing hydrogen atoms. Secondary wave (S-wave) A transverse body wave that vibrates the material through Earth's outer core. You can use these catalog numbers in your Internet search
engine to learn more about these objects, including their location in the nighttime sky. (b) Nucleons far apart F I G U R E 1 3 .1 2 (a) All nucleons in a small atomic nucleus are close to one another; hence, they experience an attractive strong nuclear force. 338 PA R T T W O CH E M I S T RY beta decays to Np-239, which in turn beta decays to
fissionable plutonium— Pu-239. (b) Ashes contain potassium carbonate, K2CO3. Name the force that occurs in a rope when both ends are pulled in opposite directions. The next time you're near a refrigerator, place your hand near the condensation coils in the back and you'll feel the heat that has been extracted from the inside. When ingested, grain
alcohol, C2H6O, is metabolized into acetaldehyde, C2H4O, which is a toxic substance that causes headaches as well as joint pains typical of a "hangover." Is the grain alcohol oxidized or reduced as it transforms into acetaldehyde? That's why distant mountains appear blue. Hewitt 122: Paul G. (d) angle of incoming light. Entropy The measure of
energy dispersal of a system. So tangential speed is directly proportional both to rotational speed and to radial distance.* CHECK POINT On a rotating axis and the outer edge and have a rotational speed of 2 m/s, what will be the
rotational and tangential speeds of your friend who sits at the outer edge? These parallel flakes give schist and gneiss a layered look—foliation. Sometimes, however, the shells and shell fragments can still be seen as in the fossiliferous limestone, coguina (Figure 20.30). Rank the blocks according to the speed light travels in each, from fastest to
slowest. The roller coaster ride starts from rest at point A. But the ions are anchored in the lattice, so they barely move at all. Earth's Internal Layers What is a possible reason for the absence of S-waves on the opposite side of an earthquake's epicenter? (a) The unsaturated hydrocarbon has more hydrogen atoms. Then the air density is doubled. More
important, however, is the fact that the stronger attraction of water molecules form intermingling. When working with electricity, rather than dealing with the total potential energy of a charged body, it is convenient
to consider the electric potential energy per charge. Which type of radiation—alpha, beta, or gamma—results in the greatest change in mass number? They have the same effect. The 2011 Japan earthquake literally changed Earth's surface. Monomers that contain three reactive functional groups can also form polymer chains. A listener can look up at
these reflectors and see the reflected images of the members of the orchestra (the plastic reflectors are somewhat curved, which increases the field of view). It is about 120,000 light-years across and about 40 times as massive as our own galaxy, the Milky Way. The rule breaks down near -273°C, where the volume does not really reach zero. Defend
your position. Beyond the chromosphere are streamers and filaments of outward-moving, hightemperature plasmas curved by the Sun's magnetic field. A wide variety of published papers EDVHGRQ16)VSRQVRUHGUHVHDUFKDQGWHVWVLOOXVWUDWHWKHEHQH¿WVRIWKH Mastering program. In fact, some gneisses are actually
metamorphosed granites. (a) What is the net force acting on the bookcase? At that time, Benjamin Franklin, the world's leading authority on electricity, was visiting Paris as a U.S. representative. Acceptance of risk, on the other hand, is a societal issue. Surrounding the core of the planet is the mantle, a rocky layer some 2900 km thick. The impulse is
the force of her hand against the bricks multiplied by the time during which her hand makes contact with the bricks. 8 Elliptical Orbits 4. Each downgoing plate, or slab, controls the downward part of a convection cell. Add these masses to get the given formula masses. The pitch of sound emitted by bats is higher than humans can hear, well beyond
20,000 Hz. 81. This means that the stars appear to move in the opposite direction, which is toward the west. One side of the molecule carries a slight positive charge, and the opposite side carries a slight negative charge, and the opposite side carries a slight negative charge.
large—beyond our intuitive grasp. The arrows represent the magnitude and direction of forces at different places. Because the boundary is so distinct, it marks an important change in the density of the materials present in Earth's interior. When air resistance is small enough to ignore, the horizontal and vertical components of a projectile's velocity
are completely independent of one another. Hewitt 224: (a, b) Addison Wesley Longman, Inc./San Francisco 227: (top) John Suchocki/Paul G. They are advised to study further if they score less than 7 correct answers. When an object isn't moving, the forces on it add up to zero—it's in equilibrium. Something at the center of a rotating platform has no
tangential speed at all, and merely rotates. (b) Mixing 200 g of sucrose in 100 mL of water at 20°C produces a saturated solution. C H A P T E R 16 32. How do two structural isomers differ from each other? He healed patients by waving magnetic wands above their heads. Suzie Skydiver with her parachute has a mass of 50 kg. This activity is a great
way of really experiencing the roundness of the Moon. We know that atoms behave like tiny optical tuning forks and re-emit light waves that shine on them. Suppose, for example, that you catch the falling pot with your hands. Work input = work output Because work equals force times distance, conservation of energy for machines tells us that input
force * input distance = output force * output distance. The alpha particle is about 8000 times more massive than an electron. The brakes must supply 16 times more work, and the stopping distance is 16 times longer (42 = 16). CHECKPOINT Which of the following activities involves the utmost human expression of passion, talent, and intelligence:
(a) painting and sculpture, (b) literature, (c) music, (d) religion, (e) science? This energy is acquired by one of the electrons. In what form is most of the energy released by atomic transmutation? How many Earth diameters would fit between Earth and the Moon? 255: Paul G. CHECKPOINT Is a buoyant force acting on you? Also, for reviews of the
astronomy chapters we remain grateful to Richard Crowe, Bjorn Davidson, Stacy McGaugh, Michelle Mizuno-Wiedner, John O'Meara, Neil deGrasse Tyson, Joe Wesney, Lynda Williams, and Erick Zackrisson. The units are subcritical. As less-dense rock rises and eventually forms new lithosphere, it takes the place of sinking, dense, old lithosphere
being pulled downward by North American Plate Eurasian Plate Eurasian Plate Eurasian Plate Eurasian Plate Eurasian Plate Eurasian Plate EQUATOR Australian Plate EQUATOR Australian Plate Eurasian Plate Eurasian Plate Eurasian Plate Filipino Plate EQUATOR Australian Plate Eurasian Plate Euras
into eight large plates and a number of smaller ones. For the same weight of fuel, nuclear reactions release about 1 million times more energy than do chemical or food reactions. (Do you see why long-range cannons have such long barrels?) 95. How is this factor of "dissolvability" related to crystallization? There are roughly 250,000 times more
atoms in a single grain of sand than there are grains of sand in the dunes shown in Figure 14.4. As small as atoms are, there is much we have learned about them. Like the circulation of atmospheric currents are driven by the heat of the Sun. Wrap part of a fur coat around a thermometer. Such stress may cause the rocks to flow like
a plastic, bending them into intricate folds. More important is the convection of air in the shower. What is the power rating of a lamp connected to a 12-V source when it carries 2.5 A? An Alka-Seltzer antacid tablet reacts vigorously with water. Why doesn't iron yield energy if it undergoes fusion or fission? Hewitt 248: (top left, middle, right)
ASSOCIATED PRESS 248: (bottom right) Richard Megna/Fundamental Photographs, NYC 249: Udo Von Mulert/Paul G. Explain. f you strike an unmounted tuning fork, its sound is rather faint. It uses the amplitude of seismic waves recorded on a seismograph. Each horizontal row is called a period, and each vertical column is called a group (or
sometimes a family). Light of different frequencies travels at different materials. Everything else, and so Earth have been pulled in; as a result, every part of the surface is equidistant from the center of gravity. 2 Magnetic Fields 9
In each case, the strength of the induced field is proportional to the rates of change of the inducing field. His mathematics teacher resigned in his favor and Newton was appointed the Lucasian professor of mathematics. A biological cell is microscopic, which means it is best viewed through a microscope. FYI 136 PA R T O N E P H Y S I CS
Applications of Bernoulli's Principle FIGURE 5.38 The paper rises when Tim blows air across its top surface. core 105° This simple picture of Earth's P-wave P-wave shadow shadow layers was refined in 1936 by zone zone Inge Lehmann, a Danish seismoloMantle gist. A transform plate boundary simply accommodates horizontal plate movement. The
answer is complex, but one important factor is that reactant molecules must physically come together. You may learn more about the nature and behavior of enzymes in a life science course. Technology that works on this scale where we engineer materials by manipulating individual atoms or molecules is known as nanotechnology. A motor pumps a
special fluid through the system, where it undergoes the cyclic process of vaporization and condensation. The energy between the two orbits. By Newton's third law, the rope pulls back on Ken, causing him to accelerate toward Joanne. If the substance that has undergone the change has new
physical properties, then the change was chemical. LEARNING OBJECTIVE Describe the three laws of thermodynamics. Although the coals are hot, does much kinetic energy when it travels three times as fast: 12 m(3v)2 = 12 m9v 2 = 9 1 12 mv 2 2. Sound
travels more slowly in the cold, denser air of the cold bottle and the note is lower. The forces on each person have the same magnitude and their masses are the same, so their accelerations are the same, so their accelerations are the same, so their accelerations are the same magnitude and their masses are the same magnitude and their masses are the same magnitude and their masses are the same. Betelgeuse emits more red light than blue light. Q158.5.H48 2012 500.2--dc23 2011029644 ISBN-10: 0-321-75334-8; ISBN-13: 978-0-321-75334-2
(Student edition) ISBN-10: 0-321-77445-0; ISBN-13: 978-0-321-77445-3 (Exam copy) 1 2 3 4 5 6 7 8 9 10—RRD—16 15 14 13 12 11 To future elementary school teachers who will inspire students to value science as a way of knowing about the world and making sense of it. Increasing frontal area reduces terminal speed. Touch the smooth side of the
zinc to the very tip of your tongue alongside a new clean penny. Quite wonderfully, everything else by a surprisingly small number of rules. A return to the original temperature restores the original bright yellow color. Like the song of old, "\u03c4, \u03c4 on the Range." 200 PARTONEPHYSICAL
SCIENCE Problem Solving Solution: SAM PLE PROBLEM 4 Rearranging Ohm's law: If your skin is very moist, so that your receive? They appear to be different shades of brightness because of the edge that separates them. a, 5. In such materials as
iron, nickel, and cobalt, however, the fields do not cancel each other entirely. C H A P T E R 15 Ion typically formed 1+ 2+ H O W ATO M S B O N D A N D M O L E CU L E S AT T R AC T 3+ 4- 3- 2- 1- 1 H 371 0 18 2 13 14 15 16 17 He Li Be B Na Mg 3 9 10 11 12 O F Ne Al Si P S Cl Ar 5 6 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr Y 8 N
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4 Rb Sr 7 C Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te Cs Ba La Hf Ta W Re Os Ir I Xe Pt Au Hg Tl Pb Bi Po At Rn Fr Ra Ac Rf Db Sg Bh Hs Mt Ds Rg Cn Uut Uuq Uup Uuh Uus Uuo = Weak nuclear attraction for valence electrons; tendency to form negative ions = Strong

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nuclear attraction for valence electrons but valence electrons that they are very difficult to remove. Does aluminum behave as an oxidizing agent or a reducing agent or a reducing agent as it restores the silver to its untarnished
state? The gravitational force pulling the droplets downward is enough to make them fall. It is composed primarily of hydrogen and helium, and it has the lowest density of any planet, only 0.7 times the density of water. Might a small ice cube also be pulled to a statically charged balloon? For deep water, the winter is not long enough to reduce an
entire pond to 4°C. Impure or contaminated water in UV light sources Potable water out Water flow FIGURE 16.29 Small-scale water-disinfecting units, such as the one shown here, hold great value in regions of the world where potable water is scarce. Note that each square contains one more grain than all the preceding squares combined. Speed is
distance per duration while velocity is displacement per duration. Clearly, we cannot have a substance with zero volume. Recall from Chapter 7 that heat naturally moves from warmer regions to cooler regions. Frequency For a vibration between the naturally moves from warmer regions to cooler regions.
all the submicroscopic particles of a material. 51. Rank the following from highest to lowest percentage of its volume above the waterline: (a) basketball floating in mercury. The variety of colors that you see in the colored photographs in this or any book is the result of
magenta, cyan, and yellow dots. This upward support force, often called the normal force, must equal the weight of the book.* If we designate the upward force as positive, then the downward force (weight) is negative, and the sum of the two is zero. How does the pencil rotate? If we think of the blown-off roof as an airplane wing, we can better
understand the lifting force that supports a heavy aircraft. Cl.. Heat from collision impacts, gravitational contraction, and radioactive decay softened our planet to a point at which its components could easily move around. A space shuttle is a projectile in a constant state of free fall. Physics professor friends include Tsing Bardin illustrating liquid
pressure on page 122, while her grandson Francesco Ming Giovannuzzi displays a fireworks sparkler on page 148. The ball must roll a greater distance as the angle of incline on the right is reduced. C H A P T E R 18 TA B L E 1 8. What change in pressure occurs in a party balloon that is squeezed to one-third its volume with no change in
temperature? The gravitational influence of the hospital building on the newborn far exceeds that of the distant planets. In the vicinity of the low (L on a map), we see an extensive cloud cover. Discuss whether or not this rule is correct. Also, its diameter is about 220,000 light-years, compared to the Milky Way's 100,000 light-years. (c) The yeast
tends to "wake up" with warmer temperatures, which is why baker's yeast is best stored in the refrigerator. The harmless compound known as table salt is composed of two very dangerous chemicals: metallic sodium and chlorine gas. Convection in the hot mantle occurs because gravity pulls the denser rock downward relative to the less dense rock,
which continues to rise. By the Pythagorean theorem, v = 2(102 + 102) = 14.1 m/s. The bow wave of a speedboat that passes by can splash and douse you if you are at the water's edge. A more common design is shown in Figure 9.19. Initially, the chlorine reacts with the ozone to form chlorine monoxide and oxygen: Cl + Chlorine O3 h ClO Ozone +
Chlorine monoxide O2 Oxygen The chlorine monoxide then reacts with another ozone molecules: ClO Chlorine atom as well as to produce two additional oxygen Mithough chlorine is depleted in the first reaction, it is regenerated in the second reaction. 760 PART F
polystyrene. From voltage = energy/charge, we get energy = voltage * charge = (12 V)(4 C) = 48 J. When air is saturated, the condensation rate (a) is greater than the evaporation rate (a) is greater than the evaporation rate. This is significant because the typical driver in the United States drives less than 40 mi a day. Energy is required to make hydrogen (to extract it from water and
carbon compounds). Likewise, reactant molecules only if the reactant molecules only if the reactant molecules possess an amount of energy equal to or greater than the activation energy. A crystal's shape, or its crystal form, is an expression of the orderly arrangement of its atoms. Formic acid, the activation energy equal to or greater than the activation energy equal to or greater than the activation energy.
pH of the blood to dangerous levels. The distance between the marks is your vertical jumping distance. If your instructor has an air table or air track, play around with carts or air pucks. If the particles are deflected while moving inside a wire, the wire is also deflected (Figure 9.17). Barbarian hordes destroyed almost everything in their paths as they
overran Europe. This current is resisted by the resistance of the first device, the resistance of the second, and that of the third, so the total resistance to current in the circuit is the sum of the individual resistance of the first device, the resistance of the first device, the resistance of the second, and that of the third, so the total resistance to current in the circuit is the sum of the individual resistance of the first device, the resistance of the first device, the resistance of the second, and that of the third, so the total resistance of the second, and that of the second is second in the second in the second is second in the second in the second is second in the se
and even lethal, when improperly handled. Light is scattered. You have a barometer of sorts, but since the medium is water, the glass would have to be 10.3 m tall to give the same pressure as a column of mercury 76 cm tall. The top floor of a building is 20 m above the basement. Their large ears help them detect these low-frequency sound waves.
This is why low-formula-mass ethers have relatively low boiling points and evaporate so readily. Ouch! Air is a very poor conductor. These relatively strong interparticle attractions hold methanol molecules together as a liquid at room temperature. High voltage may be dangerous, but high resistance is a property of all nonconductors. An incandescent
bulb that uses 100 W is brighter than one that uses 60 W. Lunar eclipse The phenomenon in which the shadow of Earth falls on the Moon, producing the relative darkness of the full Moon. (c) How do their directions of travel compare? The law of universal gravitation is a theory. If a rock contains mineral A (30% silica) and mineral B (25% silica),
which would melt first as temperature rises? That's why methane has a low boiling point, - 161°C, and is a gas at room temperature. As the Sun shines on a snow-capped mountain, much of the snow sublimes instead of melts. (a) This large-scale model of a microorganism is a physical model. If your hand touches a faulty 120-V light fixture while your
feet are on the ground, there's likely a 120-V "electrical pressure" between your hand and the ground. The oceans have been around since very early in Earth's history. This gradual change is called a periodic trend. What do peaked roofs, convertible tops, and airplane wings have in common when air moves faster across their top surfaces? You can
see both the dot and the X at this distance. 4 INTERACTIVE FIGURE Alpha particles are the least penetrating and can be stopped by a few sheets of paper. The escape was accomplished by directing the probe into the path of oncoming Jupiter. 2 2 202 4 11 0 Jul. Cooling liquid water to below 0°C causes the water to transform to solid ice, but the
substance is still water, no matter what the phase. Liquid water (dense) Ice (less dense) I
water, it bends toward the normal. Is it correct to say that the energy from a car battery ultimately comes from fuel in the gas tank? 4 Sound Waves 10. A methane molecule, for example, is made of two oxygen atoms bonded to each other. 8 Most of the stars in
this photograph are approximately the same distance—2000 light-years—from the center of the Milky Way galaxy. Although many such products operate on solid science, others are pure pseudoscience. Which teapot holds more liquid? The impact of a falling object, the slamming of a door, the roaring of a motorcycle, and most of the sounds from
traffic in city streets are noises. Your cone of vision intersects the cloud of drops and creates your rainbow. CHECKPOINT So far, you have learned about three kinds of matter: elements, compounds, and mixtures. If a rock contains both quartz and pyroxene (a silicate mineral), which melts first as the rock is heated? In ac circuits it is comparable to
resistance in dc circuits. This is because each successive wave has a shorter distance to travel and therefore arrives at B sooner than if the bug weren't moving toward B. Iron atoms, Fe, for example, are better reducing agents than copper ions, Cu2 + . A person lying on a waterbed experiences less body weight pressure because more of the body is in
contact with the supporting surface. In other words, find the wavelength of the mosquito's sound. Alex is stating the rate at which speed changes (how fast you get fast), which is acceleration. As shown in Figure 27.20, a black hole can either deflect light or capture it. In certain regions, such as the midwestern United States, the ground contains
significant quantities of the alkaline compound calcium carbonate (limestone), deposited when these lands were submerged under oceans, as has occurred several times over the past 500 million years. Mt. St. Helens in Washington is an example of an active composite cone. Thus, we now have two types of electron pairs to keep track of. (d) at no
point, since Earth always pulls more strongly. A hydrogen-oxygen fuel cell is shown in Figure 18.27. If the rocks in the fold axis are younger than those away from the axis, the fold is a syncline. (b) 1, 6, 4. One mole of water contains 6.02 * 1023 water molecules. A balloon is weighted so that it is barely able to float in water. (a) Show that the
frequency of this radiation is 10 GHz. (b) Show that the time required for a pulse of radar waves to reach an airplane 5.0 km away and return would be 3.3 * 10-5 s. In the alkaline ocean, the carbonic acid is neutralized to such compounds as calcium bicarbonate, Ca(HCO3)2, which precipitate to the ocean floor. Newton, however, recognized that a
force of some kind must act on the planets; otherwise, their paths would be straight lines. These short waves easily pass through both Earth's atmosphere and the glass windows of the car. The atoms that make up your body are mostly empty
space. Eventually, the light from the clock is visible only with your microwave telescope, followed by your radio telescope as the frequency of the light from the clock gets lower and dust storms in another. Solution: Time = distance/speed = (4.8 * 108 cm)/(2.5 telescope) followed by your radio telescope as the frequency of the light from the clock gets lower and dust storms in another.
cm/yr) If we take the current width of the Red Sea to be 300 km or 3.0 * 107 cm, and the time of spreading to be 30 million years, the speed at which the seafloor spreads is then: Speed = distance/time = (3.0 * 107 cm)/(3.0 * 107 yr) = 1 cm/yr At this rate, it will take about 400 million years for the Red Sea to be as wide as the Atlantic Ocean. Which
element has chemical properties the most similar to chlorine (Cl, atomic number 17)? Hence it floats in mercury. Carbon dioxide is a greenhouse gas, which means it helps keep Earth's surface warm by preventing infrared radiation from escaping into outer space. The components of the plasma, however, cannot be separated from one another here
because a centrifuge has no effect on solutions. Simply notice your out-breath as it leaves your body and disperses into your surroundings. The fluoride ions, such as AlOF32 - , which are then oxidized to the aluminum hexafluoride ion, AlF63 - . These two types of
crust differ in density, composition, and thickness. The force generated by a spurt is 30 N. If the photos were taken on different days, say a week apart, then the Ping-Pong ball must have been held up at the same position relative to the Sun, but away from the Moon, which would have moved toward the east where it would be a half moon. The payload
escapes. The battery is quickly ruined because placing it in the compass needles turn around, showing that the direction of the magnetic field changes also.** Earth's magnetism is generally accepted as being the result
of electric currents that accompany thermal convection in the molten parts of Earth's interior. One would expect that these two lines would overlie each other. (1 J = N # m) 42. A deep ocean trench forms offshore where the converging plates meet. At the same time, the hydrogen atoms in the water molecule develop a slight positive charge, which is
another way of saying they have lost electrons and have thus been oxidized. An airspeed of 60 km/h lands on a runway where the wind speed is 40 km/h. In an atom, an electron moves at very high speeds—on the order of 2 million m/s—and therefore exhibits many of the properties of a wave. With your classmates, discuss the science
and ethics of such a venture. (b) the same momentum and same kinetic energy. In this case, the system to be accelerated is the car. No; the effects of shortened waves and stretched waves
smokestack.) ** Entropy can be expressed mathematically. Which would keep you warmer through the cold night: a 10-kg iron brick or a
interact XJUILFZmHVSFTGSPNUIFUFYU)JOUT BOETQFDJmDXSPOHBOTXFSGFFECBDL help guide students towards mastery of important concepts. The counterclockwise cyclonic flow ceases, and clear, cold weather prevails. Processed foods cannot be rendered completely free of toxicity, for all foods are toxic to some degree. Magnetic Forces on
Moving Charges EXPLAIN THIS How does Earth's magnetic field protect us from cosmic radiation? Show that the acceleration of a hamster is 5 m/s2 when it increases its velocity from rest to 10 m/s in 2 s. But without powerful telescopes, there was no way to tell whether that was true. Why, then, do you continue running your engine? Bubbles of
oxygen gas form when hydrogen peroxide and baker's yeast are mixed. The atoms that make up a newborn baby or anything else in this world originated in the fires of ancient stars. Many minerals can be identified by their physical properties—crystal form, hardness, fracture, cleavage, luster, color, streak, and density. What is the mass of a water
molecule in grams? This arrangement is just the opposite. The surface of the resin contains many negatively charged ions bound to positively charged ions bound to positively charged ions. Hence, the specific heat of silver is about half that of iron. The added mass is due to another subatomic particle found in the nucleus, the neutron. We say water has a higher specific heat
capacity (sometimes simply called specific heat): The specific heat capacity of any substance by 1°C. Add still more energy, and the molecules break into ions and electrons, giving the plasma phase. The Sun becomes progressively redder, going from
yellow to orange and finally to a red-orange at sunset. Of the visible frequencies of sunlight, violet is scattered the most by nitrogen and oxygen in the atmosphere. Anticyclonic flow rotates clockwise around a high-pressure center. You disagree because the force of gravity on orbiting astronauts is almost as strong as at Earth's surface. Astronomers
tell us that the average temperature of the universe is a rather homogeneous 2.73 K (+/-0.0001 K). If the sewage treatment plants will be necessary 42 years later if the city grows steadily at 5 percent annually? Neither a stick of dynamite nor anything else,
a fist or a hammer, "contains" force. Adams and Urbain Leverrier, respectively, each assumed Newton's law to be valid, and they independently calculated where an eighth planet should be. The crystals sink to the bottom. We call this an elastic collision; ideally, the colliding objects rebound without lasting deformation or the generation of heat
(Figure 3.12). A friend tells you that aluminum lies beneath the layer of white plastic on a refrigerator door. Granite is a common plutonic rock. Nearly 12 million tons of polyethylene is produced annually in the United States; that's about 90 lb per U.S. citizen. 19. The side-to-side force creates vibrations that move perpendicular to the direction of
propagation. (d) 5 N west. Neutrons serve as a nuclear cement in nuclei and add to nuclear stability. This can be a change in speed only, a change in speed only, a change in direction only, or both. Adding powdered iron to a small plot of the ocean, they found, has the effect of fostering the growth of microorganisms that increase the rate at which carbon dioxide is absorbed
The remnants of the rubber underwent elastic rebound. Rank the pressures from highest to lowest: (a) bottom of a 20-cm-tall container of mercury. In the art of literature, we find out about what is possible in human experience. If your friend also
pulls with 5 N in the same direction, the net force on the box is 10 N. Why would the rodent drown if it were brought up to the water layer and the goldfish die if they swam down into the perfluorocarbon layer? Physics begins with static equilibrium so that students can start with forces before studying velocity and acceleration. A likely explanation
has to do with the oceans (Figure 18.16). So an energy unit can be a power unit multiplied by a time unit, such as kilowatthours (kWh). The molecules in the warmed air move faster, which increases the air pressure in the tires. How much more? Why doesn't water freeze at 0°C when it contains dissolved material? (c) stop getting more redshifted than
it already is. How is the physics here similar to that illustrated in Figure 1.8? 71. (a) The submicroscopic particles of the solid phase vibrate about fixed positions. Sinking air warms, and yet the downdrafts in a thunderstorm are cold. A model electric train requires 6 V to operate. It is the component K, as shown in Figure B.15, that is responsible for
the forward motion of the boat. Why doesn't dark matter clump together as effectively as ordinary matter? Note that not all periods contain the same number of elements. Perhaps he looked up through tree branches toward the origin of the falling apple and noticed the Moon. Measure their masses on a sensitive scale, such as a home postage scale.
We can even add ethanol to water until the ecule result in the formation of ethanol, rather than the water, can be considered the solvent. Rotten eggs get their characteristic bad smell from the hydrogen sulfide they release. But it's straight physics! This procedure is used by a figure skater who starts to whirl with her arms and perhaps a leg extended
and then draws her arms and leg in to obtain a greater rotational speed. How many grams of sodium chloride are required to make 3 L of a saturated solution? Hence, clouds are bright! Larger clusters of droplets absorb much of the light incident upon them, and so the scattered intensity is less. (a) Primary body waves alternately compress and
expand the material through which they travel—as shown by the different spacings between the vertical lines—similar to the action of a spring. Three main types of volcanoes exist—shield, cinder cone, and composite (Figure 20.19). Highsilica minerals are the first to melt. As heavy materials moved toward Earth's center and lighter materials moved
toward the surface, Earth's interior became layered according to density. Acceleration is directly proportional to force. When you stand on a floor, does the floor exert an upward force against your feet? Both types of surface waves travel more slowly than P-waves and S-waves, and therefore they are the last to register on a seismograph. Two facts: A
freely falling object at Earth's surface drops vertically 5 m in 1 s. What product from the combustion of the natural gas do you see condensing on the outside of the pot? When we measure something's temperature, we are really reading the temperature of the thermometer when it and the object have reached thermal equilibrium. Although changes of
resistance and current occur for the circuit as a whole, no changes occur in any individual branch in the atom, the charges balance and the atom is electrically neutral. 176 PA R T O N E P H Y S I CS CO N DE N SATIO N C RU NC H Put a small
amount of water in an aluminum soft-drink can and heat it on a stove until steam issues from the opening. The ink on the page is a different story. For example, the 1964 Anchorage, Alaska, earthquake (magnitude 9.2), released 30 times as much energy as, and produced 10 times more ground shaking than, the 1923 Tokyo Energy release (equivalent
kilograms of explosive) Energy equivalents 32,805,000,000,000 30-fold increase in energy 1,093,500,000,000 Magnitude 10 9 8 7 6 5 4 One step on magnitude scale Earthquake Near total destruction New Madrid, MO (1812) Massive loss of life San Francisco, CA (1906)
Major earthquake Severe economic impact Kobe, Japan (1995) Large loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage Light earthquake Property damage Light earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage Light earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate earthquake Property damage ($ billions) Loss of life Moderate 
the air feels. 1.0008 1 1.0006 3 Above 4°C, liquid 2 water expands as it is heated because of greater molecular motion. If bulb C is instead unscrewed, it goes out and bulbs A and B glow as before. What happens to the pressure in one part is increased? So tomorrow's weather may be very different from
today's weather. The same is true of light. Porous canvas bags filled with water are used by travelers in hot weather. How old were you when you first noticed that the shoreline margins of South America and Africa fit together like a jigsaw puzzle? This process is explored in Chapter 13. In the laboratory, endothermic reactions are usually preformed
at elevated temperatures, while exothermic reactions are usually performed at lower temperatures slow the reactive molecules down, which gives the chemist greater control. Similarly, if we lift a load two stories instead of one story, we do twice as much work because the distance is twice as great. So we see that the air we
breathe undergoes a chemical change before being exhaled. Does more current "flow" out of a battery than into it? A Honda Civic Hybrid weighs about 2900 lb. 535 Ge each kilometer of depth (Figure 20.17). The three chemicals listed below are all very weak acids because they all have a difficult time losing a hydrogen ion, H + . Explain why
occupants of the International Space Station have no weight, yet are firmly in the grips of Earth's gravity. Likewise, most modern materials, such as iron and aluminum, are made or purified using endothermic reactions. In conTUTORIAL: Solubility trast to sucrose, which has a
solubility of 200 g per 100 mL of water, only 0.004 g VIDEO: Solubility Changes with Temperature and Pressure of oxygen can dissolve in 100 mL of water, including multiple-choice questions, section-specific exercises, and general problems. This impact theory is still the
subject of much research and is thus being continually refined. The radioactive half-life of a material is also the time for its decay rate to reduce to half. These same electrical repulsions prevent us from falling through the solid floor. His father died several months before his birth, and he grew up under the care of his mother and grandmother. 326 PA
RTTWOCHEMISTRYFIGURE 13.9 Tracking fertilizer uptake with a radioactive isotope. 27.4 Could the force of gravity exerted by these celestial bodies be a legitimate factor in human affairs? If the clerk did not know that the blue beans were twice as massive as the red ones, she would not know what mass of blues was needed for the 1:1
ratio. Nucleons on opposite sides of a large atomic nucleus are not as attracted to one another. This is an extremely small force. More branches reduce resistance to motion in both circuits and toll booths. As . Hewitt 449: (left) John Suchocki/Paul G. H. * So 1 calorie = 4.19 J. With no one looking, you add 5 mL of a cinnamon solution to a blue balloon
which you tie shut. Work must be done to move a current-carrying conductor in a magnetic field. But interestingly, it doesn't expand in the temperature range between the layers. 3 8 The network of superclusters extends to the edges of
the observable universe, which is no farther than 14 billion light-years away. Its low density and its 10.2-hour rapid spin produce more polar flattening than can be seen in the other planets. Simply stated, more speed and kinetic energy mean less pressure, and more pressure means less speed and kinetic energy. For this reason, the fluorine side of
the bond is slightly negative and, because the bonding electrons have been drawn away from the hydrogen atoms, which leaves the 4 remaining valence electrons to form 2 lone pairs (nonbonding electrons). F I G U R E 4.1 6 The vertical
dashed line at left is the path of a stone dropped from rest. When both voltage and resistance are doubled? Once the alpha particle leaves the nucleus, its attraction to the nucleus by the strong nuclear force is no longer significant. But what if we saw the reverse? Caution is advised in using these products, however, because excessive quantities of
potassium salts can lead to serious illness. Neptune was added in 1846. Consider the current water disputes between countries such as Sudan and Egypt or Turkey and Iraq. The two are in opposite directions; friction opposes motion. Just as dark is the absence of light, cold is the absence of thermal energy. The price of electricity from a CO2-
take upon such a discovery? The level of treatment depends in great part on whether the treated water is to be released into a river or into the ocean. On the other hand, if the reflective surfaces are too absorbent, the sound level is low and the room may sound dull and lifeless. Net force The combination of all forces that act on an object. Protons, on
the other hand, do not move in a solid because they are bound within the nuclei of atoms that are more or less locked in fixed positions. If you try to cook food in boiling water that is collect a supercluster, which is a cluster of
galactic clusters. The force on the cannon barrel is equal and opposite to the force causing the cannon to recoil. Bottled Water Desalinated seawater and brackish water are important new sources of fresh water. In most cases, this occurs whenever a molecule loses or gains a proton—equivalent to the hydrogen ion, H+. half. (A
transformer, as we shall see in the next chapter, is a device that steps down the higher voltage supplied by the power utility.) As more devices are connected to a circuit, more pathways for current result. Bacterium Atom 10-6 m (a) 10-10 m (b) Microscopic objects can be seen through a microscope that works with visible light, but submicroscopic
the pipe, causing water to overflow at the spout. What is the difference between a black hole's photon sphere and its event horizon. FIGURE 8.26 FIGURE 8.27 The bird can stand harmlessly on one wire of high potential, but it had better not reach over and touch a neighboring wire! Why not? So, on Venus, the Sun rises in the west and sets in the
east. How few pennies can you hold and still feel the difference? (g) A, B, C, D. Because efficiency. CHECKPOINT Are there any quasars found within the Milky Way galaxy? The boiling points go up because of an increase in the number
of gallium and arsenic atoms obtained with a scanning probe microscope. These galaxies are all moving toward each other and will one day collide into a larger supergalaxy. Placing the fifth straw diagonally from corner to corner reinforces the frame even more. Brightness relates to how much energy a star produces. Interestingly, when electrical
input and light output are reversed, the resulting device is a solar cell! FYI LEARNING OBJECTIVE Relate the length and width of wires to electrical resistance. (d) Water is circulated down one hole and through the cavity, where it is superheated before rising through the cavity, where it is superheated before rising through the cavity.
same as the plane of the wave. If a charge of 2 C flashes in a bolt from cloud to Earth, show that the charge of potential energy of the charge is 2 * 108 J. In speaking of how much matter and the greater the amount of matter and the greater its inertia. In the unsaturated zone, open
pore spaces are filled with water and air, and the water is called soil moisture. We equate the heat gained by the cool water to the heat lost by the warm water. (Figure 18.15 shows calcium carbonate and is
composed primarily of chemically less reactive materials, such as granite.) Eight years later, he formed his own school. If one of the lamp filaments burns out, the path connecting the terminals of the voltage source breaks and current ceases. You have just jumped to a new observable universe. The neutrons carry no electric charge and thus have a
greater likelihood of passing through the tissue. What is the source of the enormous amount of energy released by a hurricane? Metamorphic and sedimentary rocks are made from a 4-meter rope hanging from her end of the seesaw (Figure
A.8). You can see how a raindrop disperses light in Figure 11.45. "When you're over the hill, that's when you pick up speed." —Quincy Jones In this example of straight-line motion, the acceleration is 5 km/h-second (abbreviated as 5 km/h # s).* Note that the unit for time appears twice: once for the unit of velocity and again for the interval of time in
which the velocity is changing. Rank these planets in order from longest to shortest year: (a) Mercury, (b) Venus, and (c) Earth. Some people dismiss the validity of scientific theories by saying they are "only" theories. Radioactivity is as natural as sunshine and rain. All atoms have moving electric charges. Uranium, being toward the right-hand side of
the graph, is shown to have a relatively large amount of 339 Nuclear mass C H A P T E R 13 Atomic number. The relative strengths of two acids in solution or two bases in solution, therefore, can be compared only when the two solutions have the same
concentration. His discovery was revolutionary. We can distinguish between these ideas by considering a long pipe filled with water. When the rivets cool, they contract, and this tightens the fit of the plates. Is acceleration directly proportional to force, or is it inversely proportional to force? Show that an aqueous solution having a pH of 5 has a
hydroxide-ion concentration of 1 * 10-9 M. C H A P T E R 14 65. (a) F = ma (b) Ft = ©(mv) (c) KE = 12 mv2 (d) Fd = © 12 mv2 6. Zoom out stepwise so that you can experience each stage. This upsets the timing of the engine cycle, giving rise to a knocking sound. The momentum Suppose the single car is moving at 10 m/s, and we consider the mass of
each of the freight car on the left is shared car to be m. In the next 1-second interval the average speed is 5 m/s, 25 so the distance covered is 5 meters. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Activation energy The minimum energy required in order for a chemical reaction
to proceed. More than two centuries ago, America's first great scientist, Benjamin Franklin, did similar experiments. In that case, higher-frequency notes would reach the ear of the listener first. a 6. The minerals with lower melting points do not form yet—they stay in the liquid state. A ladybug sitting anywhere on the surface of the record revolves at
33 1/3 rpm. THINKANDRANK (ANALYSIS) 29. FYI Heat of vaporization is either the energy required to separate molecules from the liquid phase. P-waves are longitudinal; they compress and expand rock as they move through it, they are fast (register first on a seismograph),
and they can travel through any type of material—solid, liquid, or gas. Earthquakes can also trigger landslides. (b) (c) C H A P T E R 16 MIX TURES 403 The process of mixing a solute with a solvent is called dissolving. Roche moutonnées are an erosional feature in which the steep side points in the direction of glacial advance. In 1672 he was elected
to the Royal Society, where he exhibited the world's first reflector telescope. Show that there is enough space between us and it to fit about 1.75 solar systems. 6.8 Thermal Expansion LEARNING OBJECTIVE Describe the role of thermal expansion in common structures. Thousands of people died, thousands were injured and left homeless, and Haiti's
infrastructure was severely crippled. The symbol for the element cobalt, for instance, is Co, but CO is a combination of two elements: carbon, C, and oxygen, O. Usually the numeral 1 is omitted when indicating either a 1+ or 1- charge. What is its acceleration? Connecting too many devices into the same circuit results in overheating the wires, which
can cause a fire. As the ball clears the net, its highest point in its path, its vertical component of velocity is zero. The oxygen in an ether, such as dimethyl ether, is bonded to two carbon atoms. Wastewater Treatment What chemical holds the record for saving the most lives? Bart Art Solution: (a) Neglecting inefficiencies, the entire initial PE of Bart
before he drops goes into the PE of Art rising to his peak—that is, at Art's moment of zero KE. Why are you then momentarily weightless? Isotopes of an element differ only by mass, not by electric charge. If your friend pulls on the box with the same magnitude of force as you in the opposite direction, the net force on it is zero. Acceleration = time ©t
2s 1 2 1 2 2 39. Similarly, a tennis player can hit a ball so it curves. Similarly, the "inertia of rotation" of rotation of rotation of rotation of rotation of rotation as small propulsion unit attached to her back. What is the dimensional geometry of a nuclear chain? The heat from the flame is
energy released when carbon and hydrogen in the air (oxidation reactions) to produce CO2 and H2O. It is a new substance formed by the reaction of these chemicals with one another. If you throw the pot FIGURE 3.8 Howie Brand shows that the block topples when the swinging dart bounces from it. What does it mean
to say that the battery in your car is rated at 12 V? Fill the can with water, which then proceeds to spurt from the hole. Carbonic acid in the ocean, however, is quickly neutralized by dissolved alkaline substances such as calcium carbonate (the ocean, however, is quickly neutralized by dissolved alkaline substances such as calcium carbonate (the ocean, however, is quickly neutralized by dissolved alkaline substances such as calcium carbonate.)
organism, as discussed in the FYI on page 479. 102. FYI TUTORIAL: Mantle Convection and Seafloor Spreading F I G U R E 2 1 .1 5 Harry Hess (1906–1969). What is the role of equations in this course? Atomic nucleus The dense, positively charged center of every atom. Interestingly, that's not what we observe! Instead, stars closer to the galactic nucleus The dense, positively charged center of every atom. Interestingly, that's not what we observe! Instead, stars closer to the galactic nucleus The dense, positively charged center of every atom.
center and those farther out orbit with about the same speed. Consider the reaction in which hydrogen atoms are bonded to hydrogen atoms are double-bonded to oxygen atoms. Hardness depends on the strength of a mineral's chemical
bonds—the stronger its bonds, the harder the mineral. The primary of a transformer connected to 120 V has 100 turns. LEARNING OBJECTIVE Review the general properties of alcohols, phenols, and ethers. (e) All of the above. (To understand this, you need to be able to deduce the chemical structures H i H for H2 and H3C i CH3 for C2H6.) The
large exothermic nature of this reaction, therefore, provides a large enough increase in the entropy of the surroundings that this reaction is favored. Twice as much mass? An hour later, a dog with its nose to the ground follows the trail of the cat. Instead, the dipoles in the water molecule work together to give an overall dipole, shown in purple, for
the molecule. Because the acceleration is zero, it follows from Newton's second law that the net force of 100,000 N and act in the opposite direction. Predict consequences that can be observed if the hypothesis is correct. If we both stood at an extreme end of the
scaffold and leaned outward, it was easy to imagine the opposite end of the scaffold rising like the end of a seesaw, with the opposite rope going limp. Gravity alters time! The stronger the gravity, the greater the effect. The most well-known Kuiper belt object is Pluto, which until recently was classified as a planet. 6. To become a negative ion, does an
atom lose or gain electrons? As a tornado moves across the land, at speeds from 45 to 95 km/h, it follows a path controlled by its parent thundercloud. The vertical component of motion for a projectile following a curved path is just like the motion described in Chapter 1 for a freely falling object. A chemical substance is uniquely different from the
elements or compounds from which it is made. Then the percentage of carbon-14 decreases at a constant rate given by its half-life. That's a conservation-of-energy no-no! Today, a child can use the principle of the lever to jack up the front end of an automobile. (Wegener wrongly proposed that the tidal influence of the Moon could produce the needed
force. What would be the consequence of a comet's tail sweeping across Earth? 28.2 Cosmic Inflation 6. After the collision, car A is observed to be at rest. All of them. Together, these superclusters appear as though they reside on the surface of a foam inside which are large voids of empty space. How does the speed of sound in water compare with
the speed of sound in air? When a cold front and a warm front merge, the result is an occluded front. Oxygen and two hydrogen atoms combine to form a water molecule. A machine cannot multiply (a) forces. Similarly, even if the chemical composition contains the necessary constituents but the pressure is not high enough, such as in contact
metamorphism, foliation cannot develop. Or do they base important decisions on astrology? (b) absorbed. What is the relationship among frequency, wavelength, and wave speed? Submerged during floods. As desalinated water is pushed out one side, the remaining salt water, which is
now even more concentrated, exits on the other side. At that time the average temperature of the universe was rather homogeneous mixture. The vibrations set up in a radio loudspeaker have the same frequencies as the vibrations (a) in
the electric signal fed to the loudspeaker. Some crystals strongly absorb one beam while transmitting the other (Figure 11.54). An electron for which n=2, n=3, and so forth is farther away, in a stepwise fashion, from the nucleus. Does Newton's law of cooling apply to warming as
well as to cooling? Elements with symbols derived from Latin names are usually those that were discovered earliest. The photosphere is the thinnest. Scientific method Principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment,
and the formulation and testing of hypotheses. In glass, light travels about 0.67c, depending on the type of glass. The disk is heated by friction where it meets the star, causing it to glow brightly. A 3-m-long wave oscillates 1.5 times each second. Because they have no mass or electric charge and because of their high energies, gamma rays can
penetrate most materials. (c) heat flow. All objects—you, your instructor, and everything in your surroundings— continually emit radiant energy over a range of frequencies. An incandescent bulb rated at 60 W draws FIGURE 8.34 a current of 0.5 A * 120 V). Moving closer still, our astronaut would find a particular distance where no
light can escape. A sailcraft can sail faster cutting across the wind than it can sailing downwind. Nine years later he wrote a second edition to his Principia. Compare the positions of the Sun in the sky when each photograph was taken. Au Atomic symbol for carbon C N A gold atom The element gold A nitrogen atom in a nitrogen molecule A carbon
atom The element carbon The element carbon The element nitrogen C H A P T E R 12 1 2 H He 3 11 12 Na Mg 19 K 37 20 6 7 8 B C N 13 14 15 Al Si 31 32 5 4 Li Be 25 27 29 9 10 O F Ne 16 17 18 P S Cl Ar 33 34 35 22 23 24 Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 41 42 21 26 45 28 30 38 39 40 52 53 54 Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe 56
57 72 85 86 55 73 74 75 44 76 77 Cs Ba La Hf Ta W Re Os Ir 87 88 89 104 105 106 107 108 109 46 78 47 79 48 80 49 81 50 82 51 83 84 297 FIGURE 12.5 The periodic table lists all the known elements. This distance is called the photon sphere. Such a gravitational lensing effect was shown in Figure 27.33. FYI 1. The engineer cited in detail the
operation of the steam cycle, how expanding steam drives a piston that in turn rotates the wheels. In light of your understanding of Newton's laws, what do you and your classmates think about this idea? What are the Brønsted-Lowry definitions of acid and base? (Try it and see!) 74. Chemical bond The force of attraction between two atoms that holds
them together. Shale (or mudstone) is formed by the compaction of superfine silt and clay-sized particles. The bottom of a boat is certainly pushed upward by water pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot, intense pressure from the weight of Earth above prevents the material of the inner core is very hot.
enough tangential speed to remain in orbit without thrust, so it must tilt until its path is parallel to Earth's surface. The structure depicted here is only a portion of the full length of the molecule. Why don't the nucleon masses add up to the total nuclear mass? (b) By the time the vibration completes one cycle, the wave travels farther in water than in
air, so the wavelength—which is the distance the wave travels in one period—is longer in water. 117. E arth's crust consists primarily of various rocks of igneous origin. This is accomplished by imparting a large spin to the ball. This is true anywhere on 2 2 3 the board. Relative humidity The amount of water vapor in the air at a given temperature,
expressed as a percentage of the maximum amount of water vapor the air can accommodate at that temperature. This results in a painful and potentially lethal medical condition known as the bends. Most of the work done in launching a rocket occurs within 10,000 km or so of Earth. yellow because it is illuminated by red and green light. The
downward force is that due to gravity. When you jump from an elevated position down to the ground, what happens if you keep your legs straight and stiff? This arrangement is called a double covalent bond or, for short, a double bond. The tin ion, Sn2+, is the oxidizing agent because it causes the silver, Ag, to lose electrons. Why doesn't the Moon
have an atmosphere? FIGURE 5.30 The force exerted on the left piston increases the pressure in the liquid and is transmitted to the right piston. But if the bug were more massive, as massive as another bus, for example, the slowing lights.
Astronomers have recently discovered an expired star that has a solid core made of diamond. A stack of an Avogadro's number of pennies would be about 800,000 trillion km, which is about the diameter of our galaxy. (d) Over millions of years, the rift continues to widen and becomes an ocean basin. The faster-traveling wave indicates a solid inner
core. Energy must be transformed within the living system to support life. Do experiments to see if the consequences you predicted are present. Such hydrocarbons are known as saturated hydrocarbons. When liquid presses against a surface, a net force is directed perpendicular to the surface (Figure 5.6). The sudden force that the cannon exerts on
the cannonball is exactly equal and opposite to the force the cannonball exerts on the cannon. 6 The present pattern of the Big Dipper is temporary. Under what conditions will a hot pie not lose heat to its surroundings? Temperature is measured in degrees. When the higherfrequency infrared waves are absorbed by your skin, as when you stand
beside a hot stove, you feel the sensation of heat. With the largest of these particles, absorption rather than scattering occurs, and a brownish haze is produced. At greater depths the pressure acting against the dam depends on the average depth of the
water and not on the volume of water held back. To read voltage? G-3 Dispersion The separation of light into colors arranged by frequency. Many of these additional hydroxide ions neutralize hydronium ions, which then become fewer. For example, a sugar molecule containing seven neutrons per carbon nucleus is digested no differently from a sugar
those of your classmates? READINGCHECKQUESTIONS (COMPREHENSION) 14.1 Chemistry: The Central Science 1. If there were no air resistance, as on the Moon, how would your answers to these questions differ? State Newton's third law. CHAPTER17HOWCHEMICALSREACT445 Endothermic Reaction: Net Absorption
of Energy When the amount of energy released in product formation is less than the amount of energy absorbed when reactant bonds break, the reaction is endothermic. F B F F C H A P T E R 15 H O W ATO M S B O N D A N D M O L E CU L E S AT T R AC T 383 FIGURE 15.27 Nitrogen is a liquid at temperatures below its chilly boiling point of
but such a balloon would be crushed by atmospheric pressure. By whom, and in what setting, was the relationship between electricity and magnetism discovered? Idealized patterns made by a bug swimming at successively greater speeds. Because the cells at the top of the tree have a higher concentration of sugars than the cells at the bottom, water
is forced to travel up the tree against gravity by osmosis. Have they dissipated, or have they grown thicker? LINK TO EARTH SCIENCE Mountains float in water. The larger the contact area, the greater the friction. The space shuttle uses hydrogen-oxygen fuel cells
2 AU of the Sun, including Mercury, Venus, Earth, and Mars—all rocky and known as the terrestrial planets. Manufactured in the United States of America. (d) The rate of evaporation increases with increasing temperature. What effect does this have on the velocity of the emerging cannonball? (Negatively charged ions, such as chloride ions, Cl-, must
also be present to balance these positively charged ions in solution.) lectrochemistry is the study of the relationship between electric energy and chemical change. This is analogous to the greater potential energy and object has when it is held higher above the ground. An ideal Polaroid filter transmits 50% of incident unpolarized light. Minerals, in
their many forms, are the building blocks of the many different rocks on Earth. The inclined-plane experiments discredited the idea that a force is needed for motion. 27.4 The Life Cycles of Stars 11. The black mailboxes, better absorbers, are somewhat warmer in sunlight or even on an overcast day than the light-colored boxes, so snow is more likely
to melt on the black surfaces than on the light ones. Both produce sediment. In one word, what is it that moves from source to receiver in wave motion? There is great misunderstanding about hydrogen. Sunsets and sunrises are unusually colorful following volcanic eruptions because particles larger than atmospheric molecules are more abundant in
the air. Our eyes sense different frequencies of visible radiation as different colors. True or false: The space shuttle orbits at altitudes in excess of 150 km to be above both gravity and the atmosphere of Earth. Why are the shadows cast by the ball cyan, magenta, and yellow? (The BandAids on his feet are for humor!) 144 PA R T O N E P H Y S I CS
122. The oxygen atom in an ether group, however, is bonded not to a carbon and a hydrogen but rather to two carbons. In this chapter we aim to present some of the more well-established findings of cosmology, which necessarily include the nature of time and space as spelled out by Einstein (Section 28.3). FIGURE 5.24 The weight of air that presses
down on a [email protected] surface at sea level is about 100,000 N. Before replying, you learn that the group's charismatic leader tells followers, "Okay, this is how we operate: First, you should NEVER question anything I tell you. However, if in real life we actually saw such things—if we could survive the shock—we would immediately sense that
time itself was running backward. 47 Water-drop region Sun 42°40° Although each drop disperses a full spectrum of colors, an observer is in a position to see only a single color from any one drop (Figure 11.46). Hold a printed page up to the double mirrors and compare its appearance with the reflection of a single mirror. The tide of scientific
opinion had indeed switched in favor of a mobile Earth. A typical NaCl crystal involves millions of ions.) (b) A view of crystals of table salt through a microscope shows their cubic structure. If all the presently remaining asteroids were scrunched together, they would make a sphere less than half the size of our Moon. This was one of the main reasons
the Statue of Liberty required a full restoration in 1976. This makes that side slightly negative, while the opposite side (lacking electrons) becomes slightly positive. Consider, for example, that personal computers didn't blossom until the 1990s, some 40 years after the first solid-state transistor. (It loses weight.) Might the charcoal be losing weight as
tiny particles (molecules) of cinnamon evaporate from its surface? Although the amount of heat generated in any cubic meters of rock within Earth, the amount of heat produced can be quite large. (d) all of these 8. Test your prediction. (c) Thick zinc walls hold in the battery acid longer.
Can you see that, even with a perfect vacuum, the maximum height to which water can be lifted in this way is 10.3 m? Energy is released as smaller nuclei fuse. Cosmic-ray intensity at Earth's surface would be greater when Earth's magnetic field passed through a zero phase because magnetic shielding is minimal. Since it falls for twice the time at
twice the average speed, it will fall four times as far. The dating of older, but nonliving, materials is accomplished with radioactive minerals, such as uranium. You know both ends are reactive because they are the ends shown in Figure 19.32. Which equation best describes each reactive minerals, such as uranium. You know both ends are reactive because they are the ends shown in Figure 19.32. Which equation best describes each reactive minerals, such as uranium.
H ≤ C CH3 H H C ≤ C O R G A N I C CO M P O U N D S 509 (a) Molecular strands of HDPE (b) Molecular strands of the same mass? Although
a space vehicle can outrun Earth's gravity, can it get entirely beyond Earth's gravity? The carbon atoms that make up Leslie's hair or anything else in this world originated in the fires of ancient stars. Can you see that the outer-shell electrons of atoms above and below one another on the periodic table (within the same group) are similarly organized?
What is the approximate age of the universe? If an object of this size has a mass of less than 1.2 kg, buoyant force is greater than weight and it rises in the air. Cumulus clouds are the most familiar of the many cloud types. Today, it is a challenge to find any consumer item that does not contain a plastic of one sort or another. On the other hand, stars
from the isolated speaker, and then hear the difference when the speaker is placed against the hole. As mentioned in the Prologue, the 16th-century Polish astronomer Copernicus caused great controversy when he published a book proposing that Earth revolves around the Sun.* This idea conflicted with the popular view that Earth was the center of
the universe. As the air parcel continues to rise, air now cools at the moist adiabatic rate. (b) Rank the current in the secondaries from greatest to least. Many more caretakers will follow. Since Freddy's mass is added, velocity must decrease. CHAPTER 7 H E AT T R A N S F E R A N D CH A N G E O F P H A S E your hand comfortably in the jet of
condensed vapor. After being closed when the current is steady? Our dependency on fossils fuels has many repercussions—both economic and environmental. Place the can open on a stove and heat it until the water boils and steam comes out of the opening. Slowly tilt the lower glass and let the air escape, filling the upper glass. Scientists have
learned how to control chemical reactions to produce many useful materials—including fertilizers from air, metals from petroleum. Water can sometimes heat faster than bubbles can form, and the water then heats beyond its boiling point—it becomes superheated. (a) C7H16. The Moon is too small with too little
gravitational pull to have an atmosphere, and so, without weather, the only eroding agents have been meteoroid impacts. To verify that it is a "pure" beta emitter, the physicist can check to make sure that the sample is emitting no alphas or gammas. Do as Professor Dan Johnson does. Some forecasts are based on the continuity of a weather pattern;
such as rain today likely means rain tomorrow. 442 PA R T T W O CH E M I S T RY F I G U R E 1 7.1 7 Chemical reactions that occur when wood is burning have a net release of energy. Simply stated, magma is derived from rocks that have melted. Eventually, the stationary drops of water grow larger and become huge compared to typical cloud
droplets—they become raindrops. More time means more significant crystallization can occur, resulting in the development of a variety of igneous rocks. Hence, ionized bracelets join the ranks of pseudoscientific devices. So how can aspirin damage your stomach? This is called the principle of floation: Only in the special case of floating does the
buoyant force acting on an object equal the object's weight. What is a node? Did Einstein first believe that the universe was static or dynamic? Newton's law of cooling The rate of loss of transfer of thermal energy from a warm object is proportional to the temperature difference between the object and its surroundings: Rate of cooling Phase The
molecular state of a substance: solid, liquid, gas, or plasma. The British diplomat, physicist, and environmentalist John Ashton, in speaking to a group of scientists, stated (paraphrased): "There has to be much better communication between the world of politics. Two common carbonate minerals are calcite and dolomite—the
magnet in half, you have two magnets. Interestingly, in ac circuits 120 V is the root-mean-square average of the voltage. For any system in which all forces are internal—as, for example, cars colliding, atomic nuclei undergoing radioactive decay, or stars exploding—the net momentum of the system before and after the event is the same. Rock candy is
a great example of crystallization in a supersaturated solution. G L O S S A RY G-11 Unsaturated solution A solution that is capable of dissolving additional solute. See also Continental drift; Plate tectonics Parabolas, 98 Parallel circuits, 203-204 overloading, 204-205 Partial melting, of rock, 535 Partial tones, 255-256 Pascal's principle, 132-133
Pelton wheel, 66 Perched water tables, 594-595 Period, of wave, 239-240 Periodic table, 296-297, 300-304 periodic table, 296-297, 30
melting, 178 Phenols, 499-500 Physical changes, 352. Why is the sound of a harp soft in comparison with the sound of a piano? (c) rotational motions. Why is a good conductor of electricity also a good conductor of heat? How will this affect the amount of water vapor in our atmosphere? What characteristic do all main-sequence stars share? The
products are carbon dioxide, water vapor, and energy. Some sufficient to are moving slowly, and others are moving quickly. (b) Space is permeated with an essence that is undetectable. The energy the man expends in pulling the rope is numerically equal to the increased potential energy of the 500-N block. Astrology is an ancient belief system that
supposes that a person's future is determined by the positions and movements of planets and other celestial bodies. If the ice cube contains grains of heavy sand, however, when it melts, the water level at the edge of the glass will drop. They expect that when our Sun transforms into a white dwarf 5 billion years from now, its ember core will
crystallize as well, leaving a planetsized diamond at the center of our solar system. The force of gravity on the payload would be strong only near Earth. The motions of stars across the night sky were natural. (The monopoles would have begun 10-38 second after the start of the
Big Bang and ended a mere 10-36 second later. In what sense does the law of reflection hold for a diffuse reflector? This is why halogen lamps have such long lifetimes. Count the tires on a large tractor-trailer that is unloading food at your local supermarket, and you may be surprised to count 18 tires. We are especially thankful to Jim Smith,
Chandrika Madhavan, and Kate Brayton. Sublimation accounts for the loss of much snow and ice, especially on high, sunny mountain tops. Does the buoyant force on a floating object depend on the weight of the object? How could an astronaut in a space vehicle "drop" an object vertically to Earth?
LEARNING OBJECTIVE Explain how reflection and refraction of seismic waves reveal boundaries in Earth's interior. The transformation of a proton into a neutron, therefore, requires a slightly greater input of energy in accordance with E = mc 2. Why will nuclear fission probably never be used directly for powering automobiles? (c) and acceleration
both decrease. What is the source of electrons that produces a shock when you touch a charged conductor? (Waning means "shrinking.") The time for one complete cycle is about 29.5 days.* CHECKPOINT 1. The atom or molecule is said to be electrically polarized. (b) When compared with other large volcanoes, its immense size and volume are
dramatic. Similarly, when mountains erode they are lighter, and are pushed up from below to float to nearly their original heights. The friction force is ordinarily the same in either case; therefore, nine times as much distance. Once a reaction is complete, however, there may be either a net release or a net absorption
of energy. But ground shaking is not the only hazard people face during an earthquake. Compared with the 1-kg ball, the 10-kg ball has (a) less momentum. 560 PARTHREEEARTHSCIENCE(a) Lithosphere Convection currents (b) Asthenosphere FIGURE 21.7 (a) A familiar example of convection is seen when water is heated in a pan. You
would consider the ages of the different rock layers. As the ground shakes, so do buildings on top of the land. Upon finding this alignment, you are looking directly at the plane of our solar system. (d) amplification. Electric Meters The simplest meter to detect electric current is a magnetic compass. Pressure exerted against the left piston is
transmitted throughout the liquid and against the bottom of the right piston. File loading please wait... 502 PA R T T W O CH E M I S T RY F I G U R E 1 9 .1 7 Ethylamine acts as a base and accepts a hydrogen ion from water to become the ethylammonium ion. No difference was found in the amount of self-reported pain relief between the group
wearing the ionized bracelets and the group wearing the placebo bracelets. (d) repelled by ordinary matter. The winds of a tornado travel in a counterclockwise direction (clockwise in the Southern Hemisphere) at wind speeds as low as 65 km/h but up to 450 km/h depending on the tornado's strength. When your car moves along the highway at a
constant velocity, the net force on it is zero. Although this spreading may seem slow, through geologic time the effect has been tremendous. What other two factors can change a rock's melting point? They contain more moisture. The inverse-square law holds for gravity and for all phenomena in which the effect from a localized source spreads
uniformly throughout the VIDEO: Inverse-Square Law Saying that F is inversely proportional to the square of d means, for example, that if d gets bigger by a factor of 3, F gets smaller by a factor of 9. REVIEW 185 108. Massive amounts of energy are released—enough to outshine an entire galaxy. Does a 2-kg iron block have twice as much inertia as
a 1-kg iron block? They are in equilibrium if Earth is neither growing nor shrinking, which is believed to be the same angle (0.5°) and appear to be the same angle (0.5°) and appear to be the same size in the sky. Why don't eclipses occur monthly, or nearly monthly? As molecules and ions are too small to see, how then does a
chemist measure the strength of an acid? Who's correct? Hotter magma flows more easily than cooler magma. The tiniest clusters, red clouds; slightly larger clusters, green clouds; and still larger clusters, red clouds; slightly larger clusters, green clouds; and still larger clusters, red clouds; slightly larger clusters, green clouds; and still larger clusters, red clouds; and still larger clusters, red clouds; slightly larger clusters, green clouds; and still larger clusters, red clouds; and still larger clusters, red
671 Uranus, 710, 721 orbit of, 96 V Valence electrons, 368 Valence shells, 313-315, 368-369 Vaporization, heat of, 179-180 Vectors, 19 Vehicles batteries for, 475 fuel cells for, 476-477 Velocity, 26-27 terminal, 44-45 Venus, 710, 715-716 Vibrations, 239-240 forced, 246-247 light waves and, 266-269 sympathetic, 247 Violent weather, 697-698
Vision, light perception and, 274 Volcanoes, 536-538 Voltage, 194 electromagnetic induction and, 225-227 transformers and, 229-230 Voltage sources, 195-196 Voltage sources, 195-196 Voltage sources, 198 Voltage sources, 198 Voltage sources, 198 Voltage sources, 198 Voltage, 198 Voltage, 198 Voltage sources, 198 Voltage sources, 198 Voltage sources, 198 Voltage sources, 198 Voltage, 198 Voltage sources, 198 Voltage sources, 198 Voltage sources, 198 Voltage sources, 198 Voltage, 198 Voltage sources, 198 Voltage
toilets, which use no water. 12:02 P.M.! We see from Table C.2 that quadrupling the resource by only two doubling times. What is the difference between humidity and relative humidity? The greater the salinity, the greater the density. And that air temperature increases when an air parcel descends? Density, of course,
becomes less with altitude. The rate of spreading at the Mid-Atlantic Ridge ranges between 1 cm and 6 cm per year. Warm air F I G U R E 1 0 .1 3 Sound waves are bent in air of uneven temperatures. And we learned that light has no mass. A fluorine atom, for example, has a strong attraction for one additional electron to fill its outermost
occupied shell. be seen or heard, but they send a The period of a wave or vibration is the time it takes for a complete vibration—pattern that tells a radio or a TV set for a complete vibration of a satellite in elliptical orbit are indicated. Therefore, it takes four times as much distance to stop. During glaciated periods, water was tied up in
glacial ice. The Kuiper belt is occupied by many rocky, icecovered objects. CHAPTER 8 S TAT I C A N D CU R R E N T E L E C T R I CI T Y The circuit shown in Figure 8.29 illustrates the following characteristics of series connections: 1. Identify each substance in these reactions as an acid or a base: (a) (b) (c) (d) H3O + + Cl - H H2O + HCl H2PO4-+
H2O H H3O + + HPO24 HSO4- + H2O H OH - + H2SO4 O2- + H2O H OH - H2SO4 O2- + H2O H OH - + H2SO4 O
Saturn's rings, only a few kilometers thick, lie in a plane coincident with Saturn's equator. Pressure in a liquid at any point is exerted in equal amounts in all directions. (The same amount of current passes through the battery.) This is the only path of the electrons through the circuit. (See Section 15.5 for a review of multiple bonds.) A hydrocarbon
containing a multiple bond—either double or triple—is known as an unsaturated hydrocarbon. What length of time is required for the Big Dipper to change from one positions. Sedimentary rocks also form when minerals
precipitate out of water solutions at or near Earth's surface. F L U I D M E CH A N I CS 121 LEARNING OBJECTIVE Distinguish between force and pressure. Erickson/ Shutterstock 605: (bottom) Michael Szönyi/ Alamy 608: NASA/GSFC/METI/ERSDAC/JAROS, and U.S./ Japan ASTER Science Team 609: (top) Leslie A. The Earth science chapters focus
on the interconnections among the geosphere, hydrosphere, and atmosphere, attached at the atmosphere, and atmosphere, and atmosphere, attached at the atmosphere, attached at the attached attached at the attached atta
of daylight? FYI As mentioned, think about the Checkpoint questions throughout this book before reading the answers. All the above emit radiant energy—even your textbook, which, like the other substances listed, has a temperature. Rank the appearance of the North Star in order of increasing height from the horizon as seen from (a) Alaska, (b)
                                                                                            (most polar) Was this your answer? READINGCHECKOUESTIONS (COMPREHENSION) 11.1 Electromagnetic Spectrum 1.5 Covalent Bonds 15. The term acid comes from the Latin acidus, which means "sour." The sour taste of vinegar and citrus fruits is due
to the presence of acids. If the beverage was primarily water, the powder did not ignite. Nonbonding N N H H H F I G U R E 1 5 .1 9 (a) A nitrogen atoms to form ammonia, NH3, a gas that can dissolve in water to make an effective cleanser. From this we see that v = at. The
net result is that the electrons do not flow through the wire, and the bulb remains unlit. This is called tacking. A typical car in 1960 emitted about 11 g of uncombusted fuel, 4 g of nitrogen oxide, and 84 g of carbon monoxide per mile from engine traveled. Beer Tomato Acidic solutions have pH values less -4 10 4 Coffee than 7. The Moon cycle begins
with the new Moon. This side immediately builds up a negative charge that repels electrons, preventing them from entering. Any material made of only one type of atom is classified as an element. 706 PARTHREEEARTHSCIENCEDISCUSSIONQUESTIONS, preventing them from entering. Any material made of only one type of atom is classified as an element. 706 PARTHREEEARTHSCIENCEDISCUSSIONQUESTIONS.
can you drive at constant speed while your velocity changes? By the time Newton was 23, he had developed his famous three laws of motion that completed the overthrow of Aristotelian physics. Then in the last instant, all atoms will be ripped apart, followed by their subatomic particles. Why are massive stars generally shorter lived than lowmass
stars? Radiation Dosage Radiation Dosage Radiation dosage is commonly measured in rads (radiation absorbed energy. The circuit is completed when this electrode is submerged in the solution. Magnetic poles exist in pairs. voltage are
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proportional to each other.* This means we'll get twice the current for twice the voltage. Consider the atoms C-12, C-14, and N-14. So we F I G U R E 4. which bypass pollution requirements. In accord with the principle of horizontal and vertical projectile motion, the time to hit the floor is independent of the ball's speed. Morphine: alcohol, phenol
ether, and amine. Foliation is the distinguishing feature. (b) A, B, C, D. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 1. (b) If air resistance can be neglected, one force pair acts: Earth's pull on the apple, and the apple a wide range
of transverse electromagnetic waves called the electromagnetic spectrum. So pressure is proportional to density. (a) is a scientific hypothesis because there is a test for wrongness. Tap water provides us with H2O as well as many other compounds, many of which are flavorful and help us grow, as Graham demonstrates at ages 7 and 21. Although
most of the salt is left behind, minute salt particles in the ocean spray can act as condensation nuclei, which aid in the formation of water vapor droplets. Pressure = weight density * depth = 9800 N/m2 * 1 m 
of lizards, which would otherwise prey upon them. When a molecule bumps into something, it exerts a small push on whatever it hits. This thick magma traps volcanic gases, which increases the pressure inside the volcano. If the induced electric fields did not in turn induce magnetic fields and transfer energy to them, the energy would be localized
rather than "waved" into space. Recall from Chapter 10 that a wave's speed depends on the medium through which it travels. Suppose that the 1.3-km main span of steel for the Golden Gate Bridge had no expansion joints. How do downdrafts form in thunderstorms? CHECKPOINT You know that a balloon rubbed on your hair sticks to a wall. Water
could instead be used to make a barometer, but the glass tube would have to be much longer—13.6 times as long, to be exact. (d) warmer. You watch a small collection of molecules that are moving around slowly while vibrating and bumping against one another. Even a warm, well-insulated house gradually cools. Each substance in a mixture retains
its chemical identity. Photosynthesis produces oxygen, O2, which migrates from Earth's surface to high up in the stratosphere, where it is converted by the energy of ultraviolet light into ozone, O3. The siren of a fire engine is heard in three situations: when the fire engine is traveling (a) toward the listener at 30 km/h, (b) toward the listener at 50 km/h, (b) toward the listener at 30 km/h, (b) toward the listener at 50 km/h, (c) toward the listener at 50 km/h, (d) toward the listener at 50 km/h, (e) toward the listener at 
km/h, and (c) away from the listener at 20 km/h. At position 1, hang a bead from a string that is 1 cm long, as shown. This magnetic field, called the magnetosphere, extends thousands of kilometers into space and shields the Earth from solar wind, which is a flow of charged particles emanating from the Sun (see Figure 9.16). Submicroscopic The
realm of atoms and molecules, where objects are too small to be detected by optical microscopes. This is because electrons continually bump into atoms in the wire. Theory A synthesis of a large body of information that encompasses well-tested and verified hypotheses about certain aspects of the natural world. Two kinds of electron motion produces, where objects are too small to be detected by optical microscopes. This is because electrons continually bump into atoms in the wire.
magnetism: electron spin and electron revolution. Air within the cumulus cloud moves in a cycle: warm air rises, cool air descends. We'd also have to overlook how difficult it was to reach a doctor in times of emergency before the advent of the telephone—when all the doctor had in his bag were laxatives, aspirins, and sugar pills—and when infant
death rates were staggering. EXPLAIN THIS The definition of work says nothing about how long it takes to do the work. 77. So there is an attraction between water and the nonpolar tails of soap. How does this compare with the nearly 40-km-high upper part of the atmosphere? (d) One second after it reaches its highest point, its velocity is - 10 m/s-
equal in magnitude but oppositely directed to its value 1 s before reaching the top. A ball would move of itself—of its own inertia, the property by which objects resist changes in motion. The warmer the ocean, the lower the solubility of any dissolved gases such as carbon dioxide, CO2. Figure B.13 shows a sailboat sailing directly downwind. The
catalyst provides an alternate and easier-to-achieve pathway along which the chemical reaction can proceed. one coil of wire to another by means of electromagnetic domains Clustered regions of aligned magnetic induction. Once a rock melts, it becomes magma. An identical twin leaves his identical twin brother behind to live on another
planet that is half as massive. The strong nuclear force is effective only over an extremely short distance. Some avoid uncertainty by uncritically accepting almost any comforting answer. If a snugly fitting steel pipe that girdled the world were heated by 1°C, it would stand about 70 m off the ground! The most straightforward way to see this is to
consider the radius of the 40,000-km-long pipe, which is the radius of Earth, 6370 km. Show that the friction force that acts on the firefighter is 480 N. Can you think of a reason why the acceleration of the object thrown downward through the air in the preceding question would actually be less than 10 m/s2? These guide students to experience
phenomena before they quantify the same phenomena in a follow-up laboratory experiment. Element Any material that is made up of only one type of atom. This indicates the solid phase. Speed = distance covered travel time For example, if a bicyclist covers 20 kilometers in 1 hour, her speed is 20 km/h. (c) How about the speed of sound in the air
between you and the locomotive? Only the fusion of light elements and the fission of heavy elements result in a decrease in nucleon mass and a release of energy. Electromagnetic waves have been measured from 0.01 Hz to radio frequencies up to 108 MHz. Then come ultrahigh frequencies (UHF), followed by microwaves, beyond which are infrared
waves, often called heat waves. Tidal forces from the nearby M81 galaxy disturb the distribution of matter within M82, which clumps, allowing for the formation of many new stars, as evidenced by M82's remarkable blue color. 6.5 The Laws of Thermodynamics EXPLAIN THIS How does thermodynamics relate to the conservation of energy? Case 1:
Increasing Momentum To increase the momentum of an object, it makes sense to apply the greatest force possible for as long as possible. We all know that Earth is round. The magnetic fields cancel. Although the number of men who benefited from bloodletting was small, testimonials of its success prompted the widespread practice that killed many
A beam of protons and a beam of neutrons of the same energy are both harmful to living tissue. PEAT steamy swamps covered much of Earth's surface. The total current in the overall circuit (the current through the battery), however, is decreased by an amount equal to the current drawn by the lamp in question before it burned out. FIGURE 4.2 The
tangential velocity of the Moon about Earth allows it to fall around Earth rather than directly into it. Why does the Sun look reddish at sunrise and sunset? The designer of an auditorium or concert hall must find a balance between reverberation and absorption. This rotation is similar to that of the arm of an arm wrestler who, with the arm just above
the table while on the brink of losing, suddenly gets a surge of strength and swings the opponent's arm (and his or her own) through a half-circle arc and wins. (d) C4H8O. 7 Boiling 7. The tops of cumulus clouds are often in the form of rising towers, showing the upward limit of the rising air. The safety net used by circus acrobats is a good example of
how to achieve the impulse needed for a safe landing. When a body of magma is nearly solidified, this very hot water circulates through fractures in the new rock and often into the surrounding rock—hydrothermal activity. 16.5 Soaps, Detergents, and Hard Water EXPLAIN THIS D How does washing soda help to clean laundry? Ammonium
dichromate, shown in Figure 14.13, is an orange material that, when heated, explodes into ammonia, water vapor, and green chromium(III) oxide. Now that you know how many moles of H2O are produced, convert this value to grams of H2O: by moles of that substance to grams (step 3) is called stoichiometry. The phase in which atoms and molecules
no longer move is the (a) solid phase. (d) stationary, occluded, and contact lifting. Gravitational potential energy g mass: acceleration due to gravity: height; PE g mgh 43. Meanwhile, the coefficient of 2 by the ammonia also makes for two nitrogen atoms after the arrow, which balances out the two nitrogen atoms appearing before the arrow. Both
accelerate equally. Note the pen "doesn't work." Now you see that gravity acts on the ink in the barrel through which the ink flows! 32. Why is a steam burn more damaging than a burn from boiling water of the same temperature? The highest tides occur during a spring tide. We know from Chapter 9 that Earth is a like a huge magnet, with its
magnetic north and south poles near the geographic poles. CHECKPOINT A friend says that the Moon does not spin about its axis, and evidence for a nonspinning Moon is the fact that its same side always faces Earth. So the solution is a = (F - f)/m (where all quantities represented are known values). An object moving at constant speed in a straight
line path is also in equilibrium. For a satellite orbiting a planet, one focus is at the center of the planet; the other focus could be internal or external to the planet. The four-straw frame is weak. In the presence of hydrogen chloride. This is an example
of forced vibration. The seismic energy that would have otherwise moved quickly through an area "piles up" instead. And even if it did, there is no scientific evidence that magnetism has any beneficial effects on the body at all. This case is treated in Chapter 13. Objects in water are buoyed upward because the pressure acting up against the bottom of
the object exceeds the pressure acting down against the top. What does the high specific heat capacity of water have to do with the convection currents in the seashore? If stored in an uncapped bottle, this compound will slowly transform into benzoic acid along the surface. When a radioactive nucleus emits an alpha or a beta particle, there
is a change in atomic number, which means that a different element is formed. Sustained nuclear fusion has yet to be achieved and remains a hope for abundant future energy. As is shown in Figure 12.12, one periodic trend is that atomic size tends to decrease as you move from left to right across any period. A 1-m-tall barrel is filled with water (with
a weight density of 9800 N/m3). The right-angled, or sideways, motion is called transverse motion. That's a lot of energy per molecule of spark. Pressure = weight density * depth Principle of floation A floating object displaces a weight of fluid
equal to its own weight. As mentioned earlier, when the force of gravity is the only force—that is, when air resistance is negligible—we say that the object is in a state of free fall. But the number of different kinds of atoms is surprisingly small. 2.4 Newton's Third Law of Motion 21. Or any good conductor is a poor insulator. Vertical acceleration is g
because the force of gravity is vertical. Figure 4.19 shows the paths of several projectiles, all with the same initial speed but different launching angles. (Pressure is directly proportional to density.) 47. So fresh water has a weight density of 62.4 lb/ft3. As in previous editions, chemistry is related to the student's familiar world—the fluorine in their
toothpaste, the Teflon on their frying pans, and the flavors produced by various organic molecules. Your friend says that, if you crank the shaft of a dc motor manually, the motor becomes a dc generator. Saying "one mole" is just a shorthand way of saying "six point oh two times ten to the twenty-third particles." Just as "a couple of" means 2 of
something and "a dozen of" means 12 of something, "a mole of" means 6.02 * 1023 of some elementary unit, such as atoms, molecules of coconuts • a dozen donuts = 12 donuts • a mole of molecules One mole of gold atoms, for example, is 6.02 * 1023 gold atoms, and 1 mole of sucrose
molecules is 6.02 * 1023 sucrose molecules. Adams' request was delayed by misunderstandings at Greenwich, but Leverrier's request was heeded immediately. Does a friction force act on the furniture? We wear metal jewelry, exchange metal currency, and drink from metal cans. 2 Relative Strengths of Acids and Bases 18. In part (a), we see the
erratic pattern of noise. So the thicker the atmosphere through which a beam of sunlight travels, the more time there is to scatter all the higher-frequency parts of the light. For a basic solution in which Soap the hydronium-ion concentration is 10 -10 1.0 * 10 - 8 M, for example, pH = Ammonia - log(1.0 * 10 - 8) = 8. Voltage doesn't flow at all but israely a light travels, the more time there is to scatter all the higher-frequency parts of the light. For a basic solution in which Soap the hydronium-ion concentration is 10 - 10 1.0 * 10 - 8 M, for example, pH = Ammonia - log(1.0 * 10 - 8) = 8. Voltage doesn't flow at all but israely a light travels, the more time there is to scatter all the higher-frequency parts of the light.
impressed across a circuit. Compounds have physical and chemical properties that are completely different from the properties of their elemental components. These are the solids you ingest with every glass of water you drink. At greater depths it is so hot that rock melts into magma, which can rise to Earth's surface to escape as lava. Note that our
Local Group is found midway between two much larger clusters, the Virgo and Eridanus clusters, the greater the amount of energy that gets dispersed. A model airplane moves twice as fast as another identical model airplane. In shorthand
notation, Impulse = Ft CHECKPOINT 1. It is no longer thorium, but the element protactinium. Syncline A down-old in rock with relatively young rocks at the fold core; rock age increases with horizontal distance from the fold core. It is our home see interactions of the and we need to learn more about it to be able to geosphere, hydrosphere, preserve
it. Why does the solubility of a gas solute in a liquid solvent decrease with increasing temperature? Pb. . Iron bar 35. (a) (b) Volcanoes not only influence the geosphere and the atmosphere, but they can even affect air travel! In April 2010, a volcanic eruption in Iceland created a huge cloud of ash that drifted all over Europe. TA B L E 1 2. However,
the action of running can make a difference. Why does decreasing the temperature of a liquid make it freeze? Once the cloud is gone, the ground reheats, allowing the air above it to warm and rise. (d) all of the above 5. What accounts for the large spaces of blue sky between cumulus clouds? In this more general sense, Faraday's law states: An
electric field is induced in any region of space in which a magnetic field is changing with time. What is induced by the rapid alternation of an electric field? Throughout the ages, what has been the general reaction to new ideas about established "truths"? The procedure repeats over and over, and an ellipse is traced during each cycle. Q = cm©T
where Q is the quantity of heat, c is the specific heat capacity of the substance, m is the mass, and ©T is the corresponding change in temperature of the substance. (a) A = B = C (no force). In fresh water, this carbonic acid transforms back to water and carbon dioxide, which are released back into the atmosphere. Atoms are so small that they can't
be seen with visible light. They are the same! When air resistance is small enough to be negligible, the time that a projectile takes to rise to its maximum height is the same as the time at takes to rise to its maximum height is the same as the time at takes to rise to its maximum height is the same as the time at takes to rise to its maximum height is the same as the time at takes to rise to its maximum height is the same as the time at takes to rise to its maximum height is the same.
nonetheless important in modern technology. Some natural gas deposits, such as those in Texas, contain as much as 7% helium. Pascal's principle underlies the operation of the hydraulic press. The porous rocks—commonly sandstones— become oil reservoirs. Carbon nanofibers are a recent discovery, however, and much research is still required to
confirm their applicability to hydrogen storage and to develop the technology. Do they form an action-reaction pair? Consider this example: Suppose we begin with 1000 kg of magma, of which 500 kg is silica. W FIGURE 6.6 The temperature of the sparks is very high, about 2000°C. Fnet = ma = (12 kg)(7.0 m/s2) = 84 kg # m/s2 = 84 N . The star
nearest Earth is (a) Proxima Centauri. What is the difference between basic research and applied research? F I G U R E 5.1 9 When the volume of gas is decreased, density and therefore pressure are increased. Place a wet Ping-Pong ball in a can of water held high above your head. 36 Rb Sr 43 ATO M S A N D T H E P E R I O D I C TA B L E Pt Au Hg
Tl Pb Bi Po At Rn 110 111 112 113 114 115 116 117 118 Fr Ra Ac Rf Db Sg Bh Hs Mt Ds Rg Cn Uut Uuq Uup Uuh Uus Uuo 58 59 60 61 62 63 64 65 66 67 68 69 70 71 Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu 90 91 Th Pa 92 93 94 95 96 97 98 99 100 101 102 103 U Np Pu Am Cm Bk Cf Es Fm Md No Lr example, the atomic symbol for carbon is
C, and that for chlorine is Cl. In many cases, the atomic symbol is derived from the element's Latin name. This is ac (and delivered to your home—we will see in Chapter 10 that transformers require ac power for operation). (a) Does the frequency that you hear increase, decrease, or stay the
derived from the fact that the planetary nebula looks like a nebula from which planets could form. At the other side of the periodic table, the nucleus of a fluorine atom tends contains 9 protons and 9 electrons. Oxides and
sulfides are important metallic mineral resources. All parts share the same rate of rotation, or number of rotatio
iron be fissioned or fused? I f you hold one end of an iron nail in a flame, the nail quickly becomes too hot to hold. Newton's third law states that the force a cannon exerts on a cannonball is equal and opposite to the force the cannonball exerts on the cannon exerts on the cannon exerts on the force a cannon exerts on a cannonball is equal and opposite to the force a cannon exerts on the cannon exerts on the cannon exerts on the cannon exerts on the force a cannon exerts on the cannon exerts on the cannon exerts on the force account exerts on the cannon exerts on the cannon exerts on the force account exerts on the force account exerts on the cannon exerts on the cannon exerts on the force account exerts on the force 
chapter, we will see that the location of the positive terminal of a 12-V battery is maintained at a voltage 12 V higher than the location of the negative terminal. (c) Oppositely charged plates. The interior of the car warms up. (Hint: speed = distance/time.) FIGURE 28.3 Hubble's original graph of velocity versus distance showing that more distant
galaxies recede with greater velocities. He formulated the law of universal gravitation. Similarly, a knowledge of science tells us what is possible in nature. Chinook—a dry wind that blows down from the Rocky Mountains across the Great Plains (Figure 25.5). Saturn is
twice as far from Earth as Jupiter is. The logarithm of 102, for example, is 2 because that is the power to which 10 is raised to give the number 102. Consider driving in a vehicle that steadily increases in speed. An Earth satellite is simply a projectile that falls around Earth rather than into it. PHOTO CREDIT S 541: (bottom) Dean Baird/Paul Hewitt
542: (a) Dorling Kindersley 542: (b) George Resch/Fundamental Photographs 542: (c) Dorling Kindersley 543: (top) Dirk Wiersma/Photo Researchers, Inc. Can silicon be mined directly from Earth? After you get the pressure of the tire on the road, compare it with the air pressure in the tire. The rate of electrical flow is measured in amperes. THINK
A N D R A N K (A N A LY S I S) 65. After a few laughs, your friend goes on to say that light is produced by the connection between electricity and magnetism. Slab-pull is the dominant force driving plate tectonics. Like a note inside a bottle cast into the sea, Pioneer 10 contains information about Earth that might be of interest to extraterrestrials, in
hopes that it will one day "wash up" and be found on some distant "seashore." It is important to stress that the escape speed of a body is the initial speed given by a brief thrust, after which there is no force to assist motion. 41 This infrared image of Pluto being orbited by its moon, Charon, is fuzzy because of the small size of these bodies and their
great distance from Earth. The method of converting grams Solution: of a substance to moles (step 1), then The 16 g of methane, CH4, is 1 mole, from moles of this substance to moles which reacts with oxygen to products. In all cases acceleration is downward, toward
Earth. The cloud maintained a constant mass as it shrank, gravitational forces grew ever stronger, and the cloud took on a spherical shape. Recrystallization may occur with or without the exchange of fluid. (c) refraction. Even if the drag of the water and all other resistance forces are negligible, the maximum speed of the boat is the wind speed.
Comets that come from the Kuiper belt tend to have orbital periods of less than 200 years. Use this formula to show that the resistance of the space heater is about 11 \(\frac{1}{3}\). Then the density of gold. Such waves of aligned vibrations are said to be polarized. A thin layer of air is dragged around the spinning
ball by friction, which is enhanced by the baseball's threads or the tennis ball's fuzz. Why might this separation method be less convenient than taking advantage of differences in the physical properties of the components? 71. Three times more leverage for the same force gives three times more torque. Then we can express Newton's third law in the
following form: To every action there is always an opposed equal reaction. In the first case, the bottom surface makes up the core—an anticline. CHAPTER 6 T H E R M A L E N E R G Y A N D T H E R M A L E N E R G Y A N D T H E R M O DY N A M I CS 2. The upper mantle, which extends from the 700-km depth upward to the crust-mantle boundary, has two zones (Figure 21.6). (b)
A whiskey still functions by the same principle. We know it isn't, because it sweetens the water. Group 18 elements are all unreactive gases that tend not to combine with other elements. Thermonuclear fusion is caused by gravitational pressure, which squashes hydrogen nuclei together. When a light source approaches, its measured frequency
increases; when it recedes, its frequency decreases. The source of all magnetism is (a) tiny bits of iron. He startles onlookers by dragging his finger through molten lead to judge its hotness (Figure 7.36). The P-waves continue to propagate through molten lead to judge its hotness (Figure 7.36).
And don't give a second thought to waterproof footwear, for the very low atmospheric pressure won't permit the existence of any puddles or lakes. Such an attraction between an ion and the dipole of a polar molecule is called an ion- dipole attraction. Likewise in our example, the wool ends up positively charged and the plastic straw ends up
negatively charged. Some carbonates, such as travertine, are formed by the inorganic precipitation of calcium carbonate (Figure 20.29). Glacial deposits tend to be poorly sorted and angular, whereas wind-blown deposits tend to be poorly sorted and angular, whereas wind-blown deposits tend to be well sorted with small particles. Which has more potential energy: an electron close to an atomic nucleus or an electron
far from an atomic nucleus? To form crystals you need a place for them to nucleate. One example is molecular nitrogen, N2. Hawaii, more than any other state in the United States, is the most efficient launching site for nonpolar satellites. The glass shatters because of resonance, when the buildup of vibrations in the glass exceeds the breaking point
of the glass. A given nova flares up at irregular intervals that may range from decades to hundreds of thousands of years. But, if a third Polaroid filter aligned at about 45° to the pair is sandwiched between them, some light does get through. Chemical sediments fall into two categories: carbonates and evaporites. T H I N K A N D S O L V E (MAT H E
M AT I C A L A P P L I C AT I O N ) 29. 126. (c) halfway from Earth to the Moon. Each electrically neutral sodium atom changes to a positively charged ion. (b) How much impulse acts on the ball? A B 100. Not good! Our skin, however, is more impervious to the destructive powers of isopropyl alcohol, which therefore serves as a good topical
antiseptic. The tabletop is distance y above the floor. Show that the second dot recedes from the first dot with a speed of 45 mm/s. Because the environmental lapse rate describes temperature changes of the surrounding air, the elevation at which a rising air parcel stabilizes can be guite variable. Metallic bond A chemical bond in which positively
charged metal ions are held together within a "fluid" of loosely held electrons. A compound is represented by its chemical formula, in which the symbols for the elements are written together. Emily will not be successful because her speed will be zero relative to the land. What is your explanation for this? Hewitt 484: (left) John Suchocki/Paul G. As
electric stresses between the oppositely charged regions build up, the charge becomes great enough that electric energy is released and passed to other points of opposite charge, which quite often means the ground. Figure 27.7 shows the distances to the seven stars making up the Big Dipper in light-years. This principle is at the heart of physics. If
amount means number of molecules, then water is the solvent. When pressure on the surface of a liquid increases, boiling is hampered. Suppose you push to the right on a heavy piece of furniture, but not hard enough to make it slide. 3.8 Machines EXPLAIN THIS Why should or shouldn't you invest in a machine that creates energy? The new rock is
stable under the new conditions, although the preexisting rock was not. For example, consider the cannon being fired in Figure 3.10. (b) Newton's laws of motion. H F F C & C H F Because the molecule on the right is less symmetrical (more "lopsided"), it is the polar molecule. Whereas scientific truth is a matter of public scrutiny, religion is a deeply
personal matter. Reaction: Object B exerts a force on object A. Try it with a metal bowl. What then is happening to the density of the universe? Solution prepared: 20 g/10 g/L = 2 L 406 PA R T T W O CH E M I S T RY LEARNING OBJECTIVE Discuss how solutes
how knowing the reasons adds to, not subtracts from, your appreciation of nature. O that moral Science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity." —Benjamin Franklin, in a letter to chemist Joseph Priestley, 8
and south from the center of our galaxy. The visible form of matter is the "ordinary matter" made of subatomic particles such as protons, neutrons, and electrons. Why would a water barometer have to be 13.6 times as tall as a mercury barometer? For example, although it was once a fact that the universe is unchanging and permanent, today it is a
fact that the universe is expanding and evolving. So we find dry, high-temperature minerals such as garnet and pyroxene at the contact. Only circuit 5 is complete and will light the bulb. Many people mistakenly believe that the astronauts who orbit Earth are "above gravity." Earth's mass is 6 * 1024 kg, and its radius is 6.38 * 106 m (6380 km). Burn it
and find out. The quality of a song depends on the arrangement of musical notes. the air. If the boxer in Figure 3.6 increases the duration of impact to three times as long by riding with the punch, by how much is the force of impact reduced? Spectra of colors appear to the left and right of the slit. When changes in the magnetic field of a current-
carrying coil of wire are intercepted by a second coil of wire, voltage is induced in the second coil. Which have more neutrons than protons: large nuclei or small nuclei? (b) rotational motion. Sedimentary rock provides a record of environmental and biological changes on Earth's surface. 6 Forced Vibrations and Resonance 10. Figure 26.1 shows the
sizes of the planets relative to the Sun, which contains a whopping 99.86% of the solar system's mass. The answer is yes: 8 km/s will be enough to clear that gap—and any gap, even a 360° gap. 5.8 Buoyancy in a Gas 27. With nowhere else to go, many of these molecules dissolve in the liquid, as shown in Figure 16.22. Even when a pot is hot, you can
briefly grasp the wooden handle with your bare hand without harm. (b) increasing. To catch the ball and then throw it back again at the same speed requires twice as much impulse. Because molecular "stickiness" can play a lead role in determining a substance's macroscopic properties, molecular polarity is a central concept of chemistry. When the
mirror is curved, the sizes and distances of object and image are no longer equal. 104 PA R T O N E P H Y S I CS FIGURE 4.23 How fast is the ball thrown? Does the overall consumption of fuel depend on whether the engine is running while the lights are on? (a) 137 amu; barium (b) 99 amu; technetium (c) 99 amu; radon (d) 142 amu; einsteinium 5.
As we will see, it accelerates. The gravity exerted by the other planets was found to account for the precession—except for 43 seconds of arc per century. More common examples of combustion include the burning of wood and fossil fuels. 6 Harnessing the Energy of Flowing Electrons 18. Because both solids and (b) Secondary wave fluids can
compress and expand, P-waves can travel through any type of material—solid rock, magma, water, or air. Work The product of the force moved by the distance moved by the distance moved by the distance moved by the distance moved.) Work
energy theorem The net work done on an object equals the change in kinetic energy of the object: This page intentionally left blank Photo Credits 1: NASA 13: Duane Ackerman/Paul Hewitt 14: John Dalton/Photo Researchers, Inc. Adding Lehmann's work to earlier findings shows the complete and current picture of Earth's internal layered structure.
At 10°C, which is more concentrated: a saturated solution of sodium nitrate, NaNO3, or a saturated solution of sodium chloride, NaCl? Movement on this type of fault is mostly up-and-down motion—the hanging wall and footwall move vertically along the fault plane. One of these was the English philosopher John Locke, who argued that observation
and reason, as demonstrated by Newton, should be our best judge and guide in all things. Return the remaining water, and as you get close to the top, ask a friend to predict whether the water level will be lower than, about the same as, or higher than before. Because the volcano was covered by ice, heat from the eruption instantly boiled to steam
which enhanced the production of very fine ash. 5 The Equilibrium Rule 1. The products of an acid-base reaction can also behave as acids or as bases. So the path of the satellite curves. As such, it has strict building codes, public earthquake-ready disaster plans. Once over land, the hurricane is deprived of its energy
source. Relax your jaw so that your lips remain slightly open. Are they correct? Table 26.1 gives the distances of planets from the Sun in AU. Both the cannonball and the Moon have tangential velocity (parachutes are deployed. Weather forecasting
is, in part, a matter of determining air-mass characteristics, predicting how and why the characteristics might change, and estimating the direction in which air masses might move. The resonant frequency of electrons in glass is in the crust, oceanic and continental crust combined, approximately 80% in the characteristics might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the characteristics might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change, and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which air masses might change and estimating the direction in which
was formed from basaltic magma, 10% from andesitic magma, and 10% from granitic magma. 180 PARTONEPHYSICS CHECKPOINT Heat of fusion is either the energy released when molecules in a liquid form bonds to create a solid. We call the energy that a
body has by virtue of its energetic jostling of atoms and molecules thermal energy. Both are correct. EXPLAIN THIS A LEARNING OBJECTIVE Describe the three atmospheric lifting mechanisms, and explain the formation of a midlatitude cyclone. (a) Basalt and granite are igneous rocks. As the syrup hits the snow, it forms a delicious taffy. We know
that when you add table sugar to a glass of water, for example, the sugar rapidly dissolves. These guidelines alone will not enable you to name every compound. Eight electrons fit into the second shell. 11.3 Reflection 8. The energy that is stored and held in readiness is called potential energy (PE) because in the stored state it has the potential for
doing work. Pressure = weight density * depth = 9800 N/m3 * (5 + 1) m = 9800 N/m3 * 6 m = 58,800 N/m2 = 58.8 kPa. 55. Node Node 4th harmonic (b) Music FIGU R E 10. If the buoyant force is greater than the weight of the completely submerged object, it rises to the surface and floats. The hot coffee has a higher temperature but not a
greater amount of thermal energy. The balance of hydronium and hydroxide ions in a neutral solution is upset by adding either an acid or a base. So dogs literally cool from the inside out when they pant. The cubic shape occurs naturally and is a reflection of how the atoms of salt are organized—cubically. Upwelling Direction of flow of mantle rock F
GURE 21.18 Mantle Convection cells In conveyor-belt fashion, new lithosphere is formed at the midocean ridges ("spreading centers") as old lithosphere is recycled back into the asthenosphere at a deep ocean trench. When passing an oncoming truck on the highway, your car tends to sway toward the truck. This is accomplished by alternating the
direction of the current with each half turn of the armature. Because mass and weight are proportional in the same location, 2 kg of anything will weigh twice as much as 1 kg of anything. This is another of the many ways in which the oceans regulate our global environment. But the current in any other single branch is unchanged. The commissioners
designed a series of tests in which some subjects thought they were receiving Mesmer's treatment but were led to believe they had not. When it has risen 5 km? Note that the alpha rays bend less than do the beta rays. For support, consider setting a clothespin or a pencil across the rim. What
happens to the vapor pressure inside? For a substance like helium, the submicroscopic particles are already in the gaseous phase at room temperature. Yes; each experiences a force because each is in the magnetic field generated by the other. Your friend Paul says that the helium used to inflate balloons is a product of radioactive decay. These
techniques are also highly effective in removing a host of other contaminants, such as pathogens, fertilizers, and pesticides. So the amount of impulse on the ball is 16 N # s. A F I G U R E 11. So a lever can be a force multiplier. Conversely, the chlorine causes oxidation of the sodium and so is acting as an oxidizing agent. Apparent polar wandering
and magnetic surveys of the ocean floor. In an ideal machine, where no energy is transformed into thermal energy, workinput = workoutput and (Fd )input = (Fd )output. Recycling aluminum, therefore, also helps minimize the need for developing new bauxite mines in foreign countries. Show that the round-trip time for the light is 2.56 s. What's
going on at the molecular level? P L U G A N D C H U G (FORMULAFAMILIARIZATION) Do these simple one-step calculations and familiarize yourself with the formulas that link the concepts of force, mass, and acceleration. So what happens to polar molecules, such as water molecules, when they are near an ionic compound, such as
sodium chloride? After 24 hours it will be slightly more to the west because of the revolution of Earth around the Sun. A stretched rubber band has potential energy because of the relative position of its parts. 10.5 EXPLAIN THIS L F I G U R E 1 0 .11 The angle of incident sound is equal to the angle of reflected sound. In the language of chemistry,
materials undergoing a chemical change are said to be reacting. A longer-term solution to acid rain is to prevent most of the generated sulfur dioxide and other pollutants from entering the atmosphere in the first place. We shall Air Clear seawater White gold be discussing solutions in more (b) Homogeneous mixtures detail in the next section.*
Current also depends on the inductance of the coil. No, because of bouncing. As such, continental crust floats higher on the mantle than oceanic crust. FIGURE 5.40 The vertical vector represents the net upward force (lift) that results from more air pressure below the wing than above the wing. Human waste loses its form by the time it reaches the
wastewater facility, and the wastewater appears as a murky stream. When air sinks, it (a) compresses and warms. (b) g F = 0, so friction = - 120 N, which is opposite in direction to the push. The moving layer of air produces a crowding of streamlines on one side. 206 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Relate current and voltage to
power with their units of measurement. (b) F = (1.0 kg) 1 2.0 ms 2 mv = t (0.2 s) = 10 kg # m s2 = 10 N (c) The time during which the tossed egg's momentum goes to zero is extended when it hits a sagging sheet. With adiabatic expansion, the temperature of a dry air parcel† decreases about 10°C for each kilometer it rises (Figure 25.4). Smoothness
and roundness of rock particles indicate travel time and hence distance. So for every hydronium ion formed, a hydroxide ion also forms. The applications of physics, chemistry, and Earth science to other massive bodies in the universe culminate in Part 4—Astronomy. (d) Powerful bases, such as sodium hydroxide, NaOH, are used in drain cleaners. 1.0
* 10-11 M, because [H3O +][OH -] must equal 1.0 * 10-14 = Kw Any solution containing an equal number of hydronium and hydroxide ions is said to be neutral. Once the train by continuously alternating the electric current fed to the coils, which alternates their magnetic
polarity. But raindrops shrink as they fall because once they are out of the cloud, the evaporation rate exceeds the condensation rate exceeds the condensation rate exceeds the condensation rate exceeds the condensation rate. The specific heat capacity of water is 1 cal/g # °C. If copper has a greater tendency to become reduced than iron, then electrons will preferentially flow from the iron to the copper (and then to oxygen as indicated in
the answer to Exercise 80). Each of the vertebrae forming your spine is separated from its neighbors by disks of elastic tissue. CHECKPOINT Methanol, CH3OH, which can be used as a fuel, is not much larger than methane, CH4, but it is a liquid at room temperature. Historically, replacing dirt roads with paved roads reduced rolling friction between
vehicles and the surface of the road. Covalent compound A substance, such as an element or chemical compound, in which atoms are held together by covalent bonds. Can a dog wag its tail without the tail in turn "wagging the dog"? Placing zero risk as a societal goal is not only impractical but selfish. Hawaii can have less stringent requirements
because it is surrounded by a very deep ocean. There's nothing at all in the open spaces, which can be thought of as empty space—a void. Leaping straight up, they seem to "hang in the air," apparently defying gravity. Add lukewarm water to two plastic cups. LEARNING OBJECTIVE Establish the rule for the attraction and repulsion of magnetic poles
When the temperatures match, the air parcel rises no farther, but it does not sink back to its starting position. It is close to the size of Mercury, which is a planet and not a moon. Nucleus Nucleus Nucleus Sucleus Nucleus Sucleus Sucleu
empty space, you create electromagnetic waves in space. In the range of visible light, forced vibration of electrons occurs at smaller amplitudes—vibration are related, a conclusion now called the principle of equivalence: Local observations made in an
accelerated frame of reference cannot be distinguished from observations made in a gravitational field. Measurements show that matter in the universe is about 75% hydrogen and 25% helium. The hang time is the same, in accord with the answer to the preceding exercise. Studies of the Milky Way suggest that it too is an intermediate spiral. Blimps
operate by way of buoyancy, airplanes by the Bernoulli principle, and rockets by way of Newton's third law. The pace picks up with the conventional order of mechanics topics followed by heat, thermodynamics, electricity and magnetism, sound, and light. Figuring Physical Science on the next page shows how these averages are calculated. 3 Buoyance
y in a Liquid 5. Note the similarity of this relationship to Coulomb's law and Newton's law of universal gravitation. If so, how should this requirement be enforced? Sodium hydroxide is a very corrosive base used for unclogging drains. Your clue to an increase in entropy here is that the crystals form "on their own," a spontaneous process and thus one
that must result in an entropy increase. In such cases, the environment disperses energy to the dissolving ions, which then spread this energy more widely into the volume of the solvent. Molarity A common unit of concentration equal to the number of moles of a solute per liter of solution. Or are these two weights the same for the special case of
floating? Which has the greater acceleration? If these stars are not already a well-known constellation and give it a creative name. Astrology is not a science does, nor are its predictions borne out by fact. The greater the entropy. Call this remains a science does, nor are its predictions borne out by fact. The greater the entropy.
the initial velocity. You can see this directly from the fact that the snowball loses mechanical energy to the air molecules it encounters, so when it returns to its starting point and to its original PE, it has less KE. Trucks often have signs on the back that say, "If you can't see my mirrors, I can't see you." Explain the physics. (a) about 16 amu (b) about
32 amu (c) about 60 amu (d) about 64 amu 3. Getting the sulfur to burn using only the oxygen in the air, however, is difficult, which is why the sulfur is blended with an oxidizing agent, such as potassium chlorate, KClO3. Once we learned how to control fire, we were able to create many new substances. For example, the claim must be reproducible
by others who have no stake in whether the claim is true or false. Refer to the Polaroids held by Ludmila back in Chapter 11, in Figure 11.58. I f you shake the end of a stick back and forth in still water, you create waves on the water, air is easily
(384-322 BC) claimed that an object falls at a speed proportional to its weight. Outward thermal expansion and inward gravitational contraction produce an equilibrium that accounts for the star's size. Sound travels faster in warm air themselves travel faster and therefore don't take as long before they bump
into one another. In what sense does the Moon "fall"? For a coat that now costs $300? The tradition of 110 V was decided upon because it made the bulbs of the day glow as brightly VIDEO: Alternating Current FIGURE 8.23 Time graphs of dc and ac. When your finger closes off the top of the water-filled straw, atmospheric pressure no longer acts on
the top part of the water, which is easily lifted. What is the buoyant force acting on it? Neutrons, on the elevation difference between the ridge and the adjacent seafloor, gravity causes the plates to slide down and outward
from the mid-ocean ridge like cookies sliding off a tilted cookie sheet. Masses of Reactants and Products form. Or, if you know the weight in newtons, divide by 10 and you'll have the mass in kilograms. Where air rises and water vapor condenses we see
clouds; where it descends we see blue sky between the clouds. Nitrogen monoxide, NO Because reaction to occur, the rate of a reaction to occur, the rate of a reaction to occur, the rate of a reaction can be increased by increasing the number of collisions. Just as there is no limit to the size of an oil-storage INTERACTIVE FIGURE depot, there is no theoretical limit to
the size of a fusion bomb. This is not true. One interesting application is shown in Figure 19.34. 540: (bottom) iStockphoto 541: (top a, b) Dr. Jeremy Burgess/ Science Photo LibraryPhoto Researchers, Inc. Because carbon is more electronegative than hydrogen, the dipoles of the two hydrogen-carbon bonds point toward the carbon. This is best
illustrated by the story of the court mathematician in India who years ago invented the game of chess for his king. If the output current is 0.36 A. Each domain consists of billions of aligned iron atoms. As you descend even deeper, their peculiar speed grows even faster
In 1913, Beno Gutenberg reinforced Oldham's earlier findings by observing that both P-waves and S-waves are strongly influenced by a pronounced boundary, FIGURE 5.42 Why does the liquid in the reservoir go up the tube? (The specific heat capacity of iron is 0.12 cal/g # °C.) Equate the
heat gained by the water to the heat lost by the nails and show that the final temperature of the water is about 21°C. This is the escape speed from the surface of Earth.** If we give a payload any more energy than 62 MJ/kg at the surface of Earth or, equivalently, any more speed than 11.2 km/s, then, neglecting air resistance, the payload will escape
from Earth, never to return. Structural groaning and creaking noises are sometimes heard in the attic of old buildings on cold nights. Elliptical galaxies are the most common galaxies.
mechanical weathering. Interestingly, time is given a direction via this thermodynamic rule. d t where d is horizontal distance traveled in time t. Hydronium ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions, are polyatomic ions, which play a role in many acid-base reactions are polyatomic ions.
generally occur about 1000 m above the ground. To most people, solutions mean finding the answers. Mass and electric charge are therefore said to be quantized in that they consist of some number of fundamental units. Similarly, the rate at which a warm house leaks thermal energy to the cold outdoors depends on the difference between the inside
and outside temperatures. Does the formation of these crystals result in an increase or a decrease in entropy? Observe the patterns of light and shadow on the ball. Winters/ Photo Researchers, Inc. But closer distances near the vicinity of a black hole, beneath the star's original radius, are nothing less than the collapse of space itself, with a
surrounding warp into which anything that passes too close—light, dust, or a spaceship—is drawn (Figure 27.19). Guisard (www.eso.org/~sguisard) 729: (bottom) David J. Beta particles, once stopped, simply become part of the material they are in, like any other electron. How much energy can be removed from a system at 0 K? Less damage is done
plugging a 220-V appliance into a 110-V circuit. Rank the following in order of increasing force of attraction between its submicroscopic particles: (a) sugar, (b) water, (c) air. The first person climbs the stairs in 30 s, and the second person climbs them in 40 s. It is the shortest distance between the applied force and the rotational axis. (b) 20,000 N.
One is filled with Styrofoam and the other one is filled with lead pellets. Carlyle didn't know that the stars above his head were only a small portion of a much larger conglomeration of stars called a galaxy. CHAP TER 26 737 9. In the pulley system shown, block A has a mass of 10 kg and is suspended precariously at rest. Every object continues in a
state of rest or at uniform speed in a straight line unless acted on by a nonzero force. And sound waves travel even faster through a solid. There are two important things to notice. A pair of electrons spinning in the same direction creates a stronger magnet. As a result, an alcohol behaves only as a very weak acid, much the way water does. When the
nuclei (cores) of atoms rearrange themselves, enormous amounts of energy can be released. The lower the efficiency of a machine, the greater the amount of energy wasted as heat.* Potential energy 79 The principle of the lever was understood by Archimedes, a famous Greek scientist in the third century BC. FYI CHECKPOINT 1. (c) Residual
Figure 18.7. Because acetic acid is a weak acid, it has much less tendency to donate hydrogen ions to water. C H A P T E R 13 Strong nuclear force (attractive) Insignificant Significant 
++ + + (b) (a) 327 THE ATO MICNUCLEUSANDRADIOACTIVITYAlarge nucleus is not as stable as a small one. Using these ideas, Bohr developed a conceptual model in which an electron moving around the nucleus is restricted to certain distances from the nucleus, with these distances determined by the amount of energy the
electron has. (a) The formation of nitrates is an example of reduction. The diesel engine coasts at 5 km/h into a freight car that is initially at rest. Railroad tracks that were laid on cold winter days expand and may even buckle in the hot summer (Figure 6.14). The progress of this supernova, shown in Figure 27.16, has been very carefully monitored by
modern scientific equipment. Streamlines are closer together between the ships than outside, so water pressure acting against the hulls is reduced between the ships. This is the mature stage, at which the thunderstorm cloud appears as a lonely giant—dark and brooding in the sky. A neutron has slightly greater mass than a proton and has no charge
What property of carbon allows for the formation of so many different organic molecules? Why doesn't gravity play a role when a ball rolls on a horizontal surface? For water, this is 334 J/g (or 80 cal/g). (c) To solve this problem, what information is assumed here that wasn't in Chapter 2? Here is a helpful mnemonic adapted from a once-popular
children's story: Leo the lion went "ger." Different elements have different oxidation and reduction tendencies—some lose electrons more readily, while others gain electrons more readily, as Figure 18.19 illustrates. Does the conical angle of a shock wave open wider, narrow down, or remain constant as a supersonic aircraft increases its speed?
Looked at another way, the submerged submarine displaces a greater weight of water than the same submarine floating. Unsaturated solution A solution A solution A solution A solution and origin are not yet fully understood. Will Maynez burns a 0.6-g peanut beneath 50 g of water, which increases in temperature from
22°C to 50°C. When current flows in the opposite direction, the cone is pushed outward. Doesn't this mean that the forces cancel each other, making acceleration is g. Gaze at the floor a couple feet ahead of you. A B 122. The sixth-period inner transition
metals are called the lanthanides because they fall after lanthanum, La. Because of their similar physical and chemical properties, they tend to occur mixed together in the same locations on Earth. 16.6 Most modern water softeners are equipped with meters that let you know the rate at which you consume water. So, when a friend says, "Look at the
pretty rainbow," you can reply, "Okay, move aside so I can see it, too." Everybody sees his or her own personal rainbow. 12.3 Protons and Neutrons EXPLAIN THIS L Why aren't we harmed by drinking heavy water, D2O? What is the color of the peak frequency of solar radiation? P = W/t = (100 J)/(2 s) = 50 W. = Water molecule entering ice crystal =
 Water molecule leaving ice crystal (a) Ice Liquid water (b) Ice Aqueous solution of NaCl CHAPTER 7 H E AT T R A N S F E R A N D CH A N G E O F P H A S E 179 At atmospheric pressure, ice forms at 0°C. This letter outlined the possibility of the chain reaction and its implications for a nuclear bomb. Rather, they pass through stages of refinement
The point directly over our heads at any time is called the zenith. (a) A bacterium is visible because it is larger than the wavelengths of visible light. Animals in the forest find shelter from the current is reversed
the magnetic force acts in the opposite direction. These planets are composed mostly of hydrogen. Gaps in the crust are produced, and large slabs of rock slide and sink down into these gaps. Pangaea The late-Paleozoic supercontinent made up of Gondwanaland (ancestral South America, Africa, Australia, Antarctica, and India) and Laurasia (ancestral
North America, Europe, Siberia, Asia). Billions of years from now, as Earth continues to slow down, a day will last about 47 hours. Some parts of Earth's surface absorb energy from the Sun more readily than others. * The nickel in this reaction is actually an intermetallic alloy of nickel and various rare-earth elements, such as lanthanum, La. Aside
from the initial charge of a brand-new battery, the energy in a car battery ultimately comes from fuel in the gas tank through the process of recharging. (b) Wood burns to ashes. Both cannonballs hit the ground at the same time, because both fall the same time.
surrounding water warms it when it might otherwise be too cold, and cools it when it might otherwise be too warm. Common rocks and minerals in our environment contain significant quantities of radioactive isotopes because most of them contain trace amounts of uranium. M inerals are classified by chemical composition (which elements are
present) and crystal structure (how the elements are arranged). We now explore cases in which one or more carbon atoms in a hydrocarbon are bonded to fewer than four neighboring atoms. Unfortunately, as long as controlling population is politically and religiously incorrect, human misery becomes the check to unrestrained population growth. One
such rocky mass became our Earth, which formed as chunks of all sizes accumulated. One-fourth of the original sample is left at the end of the second day—the three-fourths that underwent decay is then a different element altogether. 10.10 Musical Sounds 30. Hooray for bicycles and cyclists who use them! FYI 80 PA R T O N E P H Y S I CS
CHECKPOINT Inventors take heed: When introducing a new idea, first be sure it is in context with what is presently known. As they descend with a fiery glow, they are called meteors (Figure 26.39). 33. Will either pole of a magnet attract a paper clip? Then the equation is m1 m2 d2 In words, the force of gravity between two objects is found by
multiplying their masses, dividing by the square of the distance between their centers, and then multiplying this result by the constant G. T H I N K A N D S O L V E (M AT H E M AT I C A L A P P L I C AT I O N) 30. Consider an inflated balloon recoiling when air is expelled (Figure 2.22). When stress exceeds the elastic limit of the rock, the rock, or
at least the part that failed, permanently loses its original form—the rock either breaks or flows. Aeration removes many unpleasant-smelling volatile chemicals, such as sulfur compounds. 1.0004 1.0002 1.0000 0 4 8 12 Temperature (°C) 16 18 A pond freezes from the surface downward. Solution A homogeneous mixture in which all components are
dissolved in the same phase. The concept of floating mountains is isostacy—Archimedes' principle for rocks. A nice demonstration that distinguishes mass from weight is the massive ball suspended on the string breaks
when the string is jerked. When air is inside, we see that the feather falls more slowly due to air resistance. Likewise, smaller quakes—aftershocks—often follow the main quake. Note that the area under the curve is equal to the area under the curve in (a). First, in a physical change, a change in appearance is the result of a new set of conditions
imposed on the same material. The alternating stripes paralleling 90° E C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R 565 F I G U R E 2 1.16 The first detailed map of the ocean floor was created by Marie Tharp and Bruce Heezen. Your push against the floor is coupled to the floor's push against you. He was thinking
of the universe as static, neither collapsing nor expanding, 10.8 Doppler Effect EXPLAIN THIS C When does the pitch of an ambulance siren undergo change? F I G U R E 1 9.1 0 The unsaturated hydrocarbon acetylene, C2H2, when burned in this torch, produces a flame that is hot enough to melt iron. Here's a situation that should elicit good
discussion. CHAPTER 7 REVIEW 181 R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 1. If the flow of water is 10 L/min in the main pipe and 4 L/min in one of the branches, how much water per minute flows in the other branch? (c) temperature. During each second of free fall, the speed of an object (a) increases by the same amount.
Because of refraction, submerged objects appear to be magnified. 5.7 Pascal's Principle 25. Shaking the beverage also the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases the surface area of the liquid in an unopened soft bottle consists of many tightly increases area of the liquid in an unopened soft bottle consists of the liquid in an unopened soft bottle consists are also area of the liquid in an unopened soft bottle consists are also are
Hahn's evidence, Meitner concluded that the uranium nucleus, activated by neu1 The greater force is 2 Critical deformation 3 The greater force is 2 Critical deformation 3 The greater force is 2 Critical deformation 3 The greater force is 2 Critical deformation 3. This is illustrated in the reaction profile shown in Figure 17.20. Discuss at least a couple of ways that you can tell which is which without opening the boxes?
When the arrow is released, most of the potential energy of the drawn bow will become the kinetic energy of the arrow. The structure of aspirin contains a benzene ring. Such waves hitting a screen show bright light. Individual nucleons have the greatest mass in the lightest nuclei, the least mass in iron, and intermediate mass in the heaviest nuclei.
For example, if a cold front is moving eastward at an average speed of 20 km/h, it can be expected to affect the weather 80 km away in 4 hours. Similarly, winds slowly rotating over a large area speed up when the radius of rotation decreases. This is because of geometry: the ratio of surface area to mass is larger in a small piece than in a large one
(just as there is more skin on six small potatoes with a combined mass of 1 kg than there is on a single 1-kg potato). The fusion product would have atomic number 10 and atomic mass number 8, which has no energy of activation. An electric field
surrounds all (a) electric charge. Today our days are about 24 hours. According to the ideal gas law, such temperature changes do not require the loss or gain of heat—they are adiabatic. Why do we say atomic spectra are like fingerprints of the
elements? Our atmosphere, as Figure 16.1 illustrates, is a mixture of the elements nitrogen, oxygen, and argon, plus small amounts of such compounds as carbon dioxide and water vapor. The magnesium atom (atomic number 12) is found in group 2 and has two valence electrons to lose (see Figure 15.2). Reverse osmosis desalination facilities
treating brackish waters, which require much lower external pressures, are proportionately more economical. The time was right for the revolutionary concepts that follow. Layer 1 is the oldest rock, and layer 6 is the downward into a sag. As you dip your fingers more frequently into the puddle, the waves you produce are of a higher frequency (we
see the relationship between "how frequently" and "frequency"). 4 Electric Potential 8. Assume that it too has an Oort cloud about 1.6 light-years in diameter. It differs in that natural rain is the result of cooling in clouds of vapor, rather than by condensation on a chilled surface. It's from this moment that we see the cosmic background radiation
afterglow. A baseball and a golf ball have the same momentum. (a) Warm climates favor carbonates are actually more soluble in cold water than in warm water, condensation level marks the base of cloud formation. Why does a glowing splint of wood burn only slowly in air but burst into flames when placed in pure oxygen? A n
important step toward our present understanding of atoms and their spectra was taken by the German physicist Max Planck (1858-1947). Why does the direction of coastal winds change from day to night? ATO M S A N D T H E P E R I O D I C TA B L E 309 Strontium, Sr Potassium, K Barium, Ba Copper, Cu FIGURE 12.23 CHECKPOINT How might
vou deduce the elemental composition of a star? LEARNING OBJECTIVE Calculate the mass of reactants needed to products. At this moment, your speed relative to the Sun is about 100,000 km/h and even faster relative to the center of our galaxy. Various ceramic oxides have since been found to be superconducting at
temperatures above 100 K. We see how vectors help us analyze a situation so that we can see just what the problem is! FUSSDFFIGURE B.8 3. The catastrophic 2010 Haiti earthquake, magnitude 7.0, resulted in an estimated 300,000 deaths and a million people left homeless! Strike-slip faulting was involved in all three of these earthquakes. This
is nicely demonstrated when a tablecloth is skillfully whipped from beneath dishes sitting on a tabletop, leaving the dishes in their initial state of rest.* On the other hand, if an object is moving, it continues to move without changing its speed or direction, as evidenced by space probes that continually move in outer space. CHAP TER 25 Hot air from
desert Temperature inversion Cool air from the Mojave Desert overlying cool air from the Pacific Ocean. Overall resistance is lowered with each added path between
any two points of the circuit. Whereas ethanol is a liquid at room temperature (boiling point - 25°C) and mixes guite well with water, dimethyl ether is a gas at room temperature (boiling point - 25°C) and is much less soluble in water. Sketch their pattern on a piece of paper and write down the date and time at which you make this observation. The
submicroscopic pores of a semipermeable membrane squeezed back across the membrane by the osmotic pressure. The element bromine, Br (atomic number 35), has two major isotopes of similar abundance, both around 50%. One outstanding question was why the cosmic background radiation is so uniform in its temperature. What happens to the
air pressure and temperature of an air parcel as it flows up the side of a mountain? How many moles of sucrose are in 0.5 L of a 2 M solution? (b) Detail of an ant as seen with an electron microscope at a "low" magnification of 200*. It showed that Neptune has at least 13 moons in addition to a ring system. Suppose the voltage is lowered by 10% to
108 V. With an acidic solution, the cuticles close shut so that the dye binds only to the outside of each shaft of hair. eteorologists have the important job of forecasting hurricanes and other storms. Catalyst Any substance that increases the rate of a chemical reaction without itself being consumed by the reaction. Step 4: Put on safety glasses and turn
the burner on low to bring the water to a low boil. Higher frequencies are measured in kilohertz (kHz), and still higher frequencies in megahertz (MHz). The ground then pushes harder on them, producing a net force in their favor. 20.2 Minerals 5. 7 Electrical Resistance 8. Which law of thermodynamics relates to a system reaching 0 K? What if this
person is actually a future you? Higher temperatures produce a yellowish light. Why are hurricanes more likely to occur on the East Coast of the United States than on the West Coast? C arbon atoms can bond to one another and to hydrogen atoms in many ways, which results in an incredibly large number of hydrocarbons. Electromagnetic wayes
depend on mutual field regeneration. Consider the identical balls released from rest on tracks A and B, as shown. The fuzz takes on more of an oval shape when viewed through a good pair of binoculars. Thanks also goes to Leslie's children, Megan and Emily, for their inspiration, their curiosity, and their patience. The modWarm Cold ern view of
midlatitude cyclones invokes the idea of three major conWarm front Cold front veyor belt, a cold conveyor belt, a cold conveyor belt, a cold conveyor belt, and a dry conveyor belt, a cold conveyor belt (Figure 25.16). If you were to travel straight up from the core of our galaxy and then look back, you would have a grand view of the Milky Way's spiral shape. Silica content determines
the melting point. The rules of electricity in this chapter apply to both dc and ac. Similarly, the shadow cast by the vellow lamp appears blue. How many Earth-Proxima Centauri distances is that? Fossil organisms succeed one another in a definite and irreversible order, so they are used to help correlate rocks of similar age in different regions because
any time period can be recognized by its unique fossil content. When we consider any system in its entirety, whether it be as simple as a swinging pendulum or as complex as an exploding supernova, one quantity isn't created or destroyed: energy. LEARNING OBJECTIVE Summarize general relativity and the three successful predictions made by this
theory. If amount means mass, then sucrose is the solvent. Tammy and Larry Tunison demonstrate radiation safety on page 325. Stir about half a teaspoon of salt into about half a cup of white distilled vinegar. A reversal of magnetic poles occurs every 11 years, and the number of sunspots also reaches a maximum every 11 years (currently). What
happens to the overall kinetic energy in a liquid when the high-energy molecules leave? Each device operates independently of the other devices (whether the circuit is ac or dc). If you swim in salt water, is the pressure greater than in fresh water at the same depth? In what is now known as the Hall-Heroult process, shown in Figure 18.31, a strong
electric current is passed through a molten mixture of aluminum oxide and cryolite, Na3AlF6, a naturally occurring mineral. In the old age of an average-mass star like our Sun, as the supply of hydrogen fuel diminishes, gravity overwhelms thermal pressure and the star pulls inward. When heated rock expands it becomes less dense, and when cooled
rock contracts it becomes more dense. One reason is that they didn't yet travel in high-speed vehicles. This relationship is called Boyle's law, after Robert Boyle, the 17th-century physicist who is credited with its discovery.* Boyle's law applies to ideal gases. Which team wins in a tug-of-war: the team that pulls harder on the rope or the team that
pushes harder against the ground? Some remain in the ice-water mixture, making up a microscopic slush that slightly "bloats" the water—increases its volume slightly (Figure 6.21). To find the pH of this 10 1 -1 Concentrated HCl solution, we first take the logarithm of this value, which is -7 (see Figuring 10 0 0 Battery acid Physical Science). 3.9
Efficiency EXPLAIN THIS T he three previous examples were of ideal machines; 100% of the work input appeared as work output. I saac Newton was the first to realize the connection between force and mass in producing acceleration, which is one of the most central rules of nature. Both. The water hose does not recirculate the water as the auto
cooling system does. Examine the color in any of the figures in this or any book with a magnifying glass and see how the overlapping dots of these colors. Earth's curvature "drops" 5 m for each 8-km tangent. To this day uranium isotope separation remains a difficult process. (a) Show that the height reached by the ball is
gt 2/8. Could you safely walk across a bed of red-hot wooden coals with bare feet? Note that the number of covalent bonds formed by these and other nonmetallic elements parallels the type of negative ions they tend to form (see Figure 15.6). Crystallization occurs step by step in a temperature-dependent sequence. A long steel bridge usually has one
end anchored while the other rests on rockers (Figure 6.15). (Shown below is a photo of coauthor Leslie at age 16.) 44. It would rise to some maximum height, reverse direction, and then fall back to Earth. Friction is due to tiny surface bumps and also to the "stickiness" of the atoms on the surfaces of the two materials (Figure 1.16). But light incident
on a wet surface bounces around inside the transparent C H A P T E R 11 LIGHT 269 The human eye can do what no camera can do: it can perceive degrees of brightness over a range of about 500 million to 1. They are joined by a safety cord whose ends are tied around their waists. Conformation One of a wide range of possible spatial orientations of
a particular configuration. Line 110 to 120 V ac is applied across these lines by a transformer in the neighborhood. This is like emptying an average-size swimming pool in 20 s. This effect, which was advanced by the British physicist James Clerk Maxwell in about 1860, is known as Maxwell's counterpart to Faraday's law: A magnetic field is induced in
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any region of space in which an electric field is changing with time. The descending part of the plate—the "slab"—heats up, but generally does not melt, as temperature and pressure rise deeper in the mantle. The extremely fine particle size indicates deposition in a low-energy environment characterized by quiet waters, such as deep ocean basins
flood plains, deltas, lakes, or lagoons. A student is told to use 20.0 g of sodium chloride to make an aqueous solution that has a concentration of 10.0 g/L (grams of sodium chloride per liter of solution). In fluids, however, positive ions as well as electrons may constitute the flow of an electric charge. CHAP TER 25 D R I V I N G F O R CE S O F W E AT
H E R 699 Thunderstorms A thunderstorms A thunderstorm begins with humid, unstable air rising, cooling, and condensing into a single cumulus cloud. Mercury is the only planet close enough to the Sun for the curvature of space to produce an effect on it that is not predicted by Newton's law. Likewise with heat. A small light source located 1 m in front of a
[email protected] opening illuminates a wall behind. LEARNING OBJECTIVE Compare the composition and density of elements at Earth's interior. REVIEW 361 F I G U R E 1 4 .1 9 An artist's rendition of the interaction between surface carbon atoms and the tip of a scanning probe microscope. Although this is a reasonable
 assumption, in reality evaporation and precipitation tend to pretty much balance. (d) Boyle's law. 13 2012 No 20 Jul .0 2. The graph of Figures 13.30 (and Figures 13.31 and 13.32) reveals the energy of the atomic nucleus, a primary source of energy in the universe—which is why it can be considered the most important graph in this book. When these
ions join water molecules, heat is given off, which melts microscopic parts of an icy surface. Because this number of grams of lithium is numerically equal to the atomic mass, the sample contains 6.02 * 1023 lithium atoms, which is 1 mole. Using equations for four-dimensional spacetime, Einstein recalculated the orbits of the planets about the Sun.
The vast distances between the Sun and the objects orbiting it can be grasped by imagining the Sun reduced to the size of a large beach ball 1 m in diameter. These are semiconductors. (The greater mass of octane also plays a role in making its boiling point higher.) Induced dipole-induced d
explain how the gecko can race up a glass wall and support its entire body weight with only a single toe. Alternating current (ac) An electric current that repeatedly reverses its direction; the electric charges vibrate about relatively fixed points. (b) 5-kg rock has greater acceleration. (b) Water continues to flow because a difference in pressure is
maintained with the pump. If a star such as our Sun, however, were to collapse to a radius of 3 km, the escape velocity from its surface would exceed the speed of light, and nothing—not even light—could escape. Perhaps someday a flaw in the law of energy conservation will be discovered. 2 To apparent position of Sun Actual light path To true po
sition of S un Because of atmospheric refraction, when the Sun is near the horizon it appears to be higher in the sky. So, both force and time interval are important in changing momentum. A tsunami is generated from the displacement of water as a result of an earthquake, a submarine landslide, or an underwater volcanic eruption. The hydrogen on
the nitrogen is able to participate in hydrogen bonding with water, which makes this compound somewhat soluble in water. 2 2 Sam, like other dogs, has no sweat glands (except between his toes). (d) doubles. In Chapter 15 we will use a simplified version of this model, called the electron-dot structure, to show how atoms join together to form
molecules, which are tightly held groups of atoms. What is the halflife of the radioactive isotope? (b) Boiling this water at 100°C takes 540 cal, considerably more energy than it took to bring the water atl the way from absolute zero to the boiling point! (In fact, at very low temperature, the specific heat capacity of ice is less than 0.5 cal/g # °C, so the
true difference is even greater than calculated here.) 51. A graph of the nuclear masses for the elements from hydrogen through uranium is shown in Figure 13.29. Others include photosynthesis, cellular respiration, and molecular genetics. As you might imagine, this system is very intricate. Just as a cook looks to a recipe to find the necessary
quantities measured by the cup or the tablespoon, a chemist looks to the periodic table to find the necessary quantities measured by the number of grams per mole for each element or compound. Buoyant forces acting on the submerged block is the
same at any depth. F I G U R E 8 .1 0 INTERACTIVE FIGURE Some electrons emit electromagnetic waves. Corrective thrusters direct the rocket to this new path. (c) both of these (d) neither of these Answers to RAT 1. Where is your image when you look at yourself in a plane
mirror? Small alcohols are soluble in water because it is less symmetrical (c) the molecule on the left, SCO, because it is more symmetrical (d) the
molecule on the right, OCO, because it has more mass REVIEW 16 C H A P T E R 1 6 Mixtures H ow can fresh water be prepared 16. Because period is the inverse of frequency, the formula wave speed = wavelength WAV E S A N D S O U N D 241 Wavelength FIGURE 10.4 A top
view of water waves. See also Solutions suspensions, 401 Mohorovic i'c discontinuity, 557 Mohs scale of hardness, 526 Moleculer polarity, 382-385 Moleculer, atmospheric, 683-686 Molar mass, 433 Molarity, 404 Moleculer polarity, 382-385 Moleculer, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, atmospheric, 683-686 Molar mass, 433 Molarity, 557 Mohs scale of hardness, 526 Moisture, 557 Mohs scale of hardness, 526 Moisture, 557 Mohs scale of hardness, 557 Mohs scale of hardness, 558 Molar mass, 558 Molar m
What must the body do to this elemental iron to make use of it: oxidation or reduction? The sedimentary rock had to be there before the fault in order for the fault in order for the fault in order all, the ocean tides are the result of
the Moon's and Sun's positions, and the gravitational pulls between the planets perturb one another's orbits. A little more than 3 billion years ago, meteoroid bombardment and volcanic activity filled basins with lava to produce its present surface. Will it be in the same location in 24 hours? When the train rounds a curve? In fact, when the air
temperature reaches 12°C, the evaporation rate and the condensation rate would be equal and the relative humidity would be saturated. The fault is older than the basalt and younger than the basalt and younger than the sedimentary rock. Acidic Description of a solution in which the hydroniumion concentration is higher than the hydroxide-ion
concentration. More water means more discharge increases. With gravity it falls about (a) 1 m below that line. van Ravenswaay/Photo Researchers, Inc. Period can be calculated from frequency, and vice versa. What physical quantity is a measure of how much inertia an object has? Interestingly, the engines of modern cars are designed
to run best on 87 octane grade fuel. Why is a generator armature harder to rotate when it is connected to a circuit and supplying electric current? In terms of the periodic table, is there an abrupt or a gradual change between ionic and covalent bonds? Which has the highest surface temperature: a red star, white star, or blue star? For example, the
mineral apatite is used to make fertilizer. Larger motors, do or ac, are usually manufactured by replacing the permanent magnet by an electromagnet that is energized by the power source. About how fast does an electromagnet that is energized by the power source that lowers the melting point of the rock—
enough to cause melting. Raising the temperature by 100°C takes 100 times as much, or 450,000 J. The relative humidity is 100% and the was added—the air was no longer saturated at the higher temperature. Ten inner-shell electrons (10 - ) shield the electron in the outermost shell from this
positive charge. Gneiss (pronounced "nice") is a foliated metamorphic rock that contains alternating layers of dark platy minerals and lighter granular minerals. Phase The molecular state of a substance: solid, liquid, gas, or plasma. Cumulus clouds resemble pieces of floating cotton, with sharp outlines and flat bases. We see that 3 moles of oxygen
gas are produced for the reaction of every 2 moles of KClO3 solid. From 0°C water, cm©T, requires 100 cal. 4 Catalysts 17. For example, in designing the Sacagawea dollar coin, shown in Figure 15.13, the p Electron Mh Metal ion U.S. Mint needed a metal with a gold color—so that it would be easy to recognize—and also have the F I
G U R E 1 5 . Rank the volume of air in the glass, from greatest to least, when it is held (a) near the surface as shown, (b) 1 m beneath the surface, and 13 through 18. The concept of potential energy per charge is called electric potential.
that is, Electric potential = The unit of measurement for electric potential is the volt, so electric potential is often called voltage. Blue light has a higher frequency than red light and therefore corresponds to a greater energy transition. Let's look at this process from a stepby-step mathematical point of view. What distinguishes an alcohol from an
ether? The hairs act like leaves R in an electroscope. The 1-kg cart will have more acceleration—twice as much, in fact— because it has half as much mass, which means half as much resistance to a change in motion. Furthermore, the sharp
boundary between Depth (km) FIGURE 21.4 Cross-section of Earth's internal layers, showing the increases and decreases of P-wave and S-wave velocity in the different layers. When the current is unknown, the power can be expressed as P = V 2/R. 11.5 Color 16. With respect to stellar evolution, what is meant by the statement, "The bigger they are
the harder they fall"? The star balloons to become a giant (position 2). This coincidence allows us to see solar eclipses. A pressure exerted by a dollar bill resting flat on a table. Another onlooker sympathizes with you because he knows how difficult it is to navigate through an unfamiliar city.
Lead isotopes 206 and 207 that now exist were at one time uranium. Yet astrology is not a science because there is no validity to the claim that the positions of celestial objects influence the events of a person's life. Vacationer's density = (0.90)(1025 kg/m3) = 923 kg/m3. The Sierra Nevada batholith is a remnant of the original volcanic range, while
the California Coast Range has remnants of the sediments that accumulated in the trench. So rather than building into a planet, this material is slowly ground down and pushed off course. Virtually the entire state of Nevada, eastern California, southern Idaho, and western Utah are greatly affected by normal faulting. Show that a
total of 36,000 calories is required to change 50 g of 0°C ice to steam at 100°C. Despite their limitations, such images are excellent guides to learning about the behavior of atoms, especially for the beginning student. By 1200 BC, even hotter furnaces were converting iron ores to iron. So, although Antares is much larger, it is also much less dense.
EXPLAIN THIS W hen an unstable air parcel rises, the relative humidity increases as the air cools at the dry adiabatic lapse rate. It can be passed from one object to another but it cannot be lost. F I G U R E 1 2 .1 An image of carbon atoms obtained with a scanning probe microscope. 5 Pressure in a Gas 5. The atomic mass is 99 amu, and the element
is technetium, Tc, with atomic number 43. This means that the charge of the object is a whole-number multiple of the charge of an electron. A total eclipse is seen from within the umbra and may last several minutes. So not only are we a nice distance from the Sun, but our atmosphere contains just enough water vapor and carbon dioxide to keep
temperatures favorable for life. In fact, staring at the bare Sun is more harmful than when part of the Moon blocks it. (a) From - 273°C "ice" to 0°C ice requires (1 g)(0.5 cal/g # °C) (273°C) = 140 cal. Sheet-structured minerals such as the micas orient themselves perpendicular to the direction of maximum pressure. In Chapter 26, we discussed the
nebular theory, which explains how the Sun formed from an expansive, low-density cloud of gas and dust called a nebula (Figure 27.11). When these rocks undergo partial melting, basaltic magma is formed. 61. The leftmost diagram below shows two phases of a single substance. The speed of something moving along a circular path is tangential
speed, because the direction of motion is tangent to the circle. Both primary and secondary coils are wrapped on the inner part of the iron core (yellow), which guides alternating magnetic field lines (green) produced by ac in the primary. What physics principle does Manuel use when he pumps in rhythm with the natural frequency of the swing? A
clock runs slower at the bottom of a skyscraper O D D - N U M B E R E D S O LU T I O N S than at the top. Which contains only a compound? 20.6 Rock Types EXPLAIN THIS LEARNING OBJECTIVE Define the three categories of rocks. Before he died in 2005, Rick Smalley, codiscoverer of the buckyball molecule, advocated that carbon nanotubes, if
developed into wires, could be an ideal material for efficiently transporting electricity over vast distances. Notice that these projectiles reach different altitudes, or heights above the ground. Place the proper number of electrons in each shell. So why don't they fall? Reacts with carbon dioxide and water to form the greenishblue substance called
patina. For humankind this led to increased humility, but also to hope and inspiration because of the evidence of a rational order. Polar Description of a chemical bond or molecule that has a dipole. Would healthy 200-year-olds be set in their ways or still open to change? It occurs in the organic compounds known as ketones, aldehydes, amides,
carboxylic acids, and esters. Try the following problems to better appreciate the sizes of bodies in the solar system and distances between them. The speed of any reaction is indicated by its reaction rate, which is an indicator of how quickly the reactants transform to products. If not from the Big Bang, then where do elements heavier than helium
come from? FIGURE 11.15 The open-mesh parabolic dish is a diffuse reflector for shortwavelength light but a polished reflector for long-wavelength radio waves. At the other extreme, a fighter plane designed for high-speed flight has a small wing area relative to its weight. As you come closer, the gravitational pull on your feet would far exceed
that on your head. Solution: There are several ways to answer this problem. FYI Was this your answer? When you leap, you impart the same momentum to both yourself and the canoe. Because the different components of the ink have different affinities for the solvent (based on the attractions between component molecules and solvent molecules),
they travel with the solvent at different rates. A merchant in Kathmandu sells you a solid-gold, 1-kg statue for a very reasonable price. 416 PA R T T W O CH E M I S T RY solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical, especially when the maintenance costs of vast fields of solar distillation is less practical.
process you never need to say that molecules exist because someone told you they exist. Gravity thus predominates and the entire star begins its final contraction. If the speed of sound and the speed of light were the same, then you'd hear a plane where it appears in the sky. Convection in the hot mantle occurs because gravity pulls cooled, denser
rock downward relative to heated, less-dense rock, which continues to rise upward. One complete rotation of the loop produces one complete rotation of the sun's energy is used to drive
 OBJECTIVE State Newton's first law of motion, and relate it to inertia. Continental drift A hypothesis by Alfred Wegener that the world's continents are mobile and have moved to their present positions as the ancient supercontinent Pangaea broke apart. The displaced water, with a volume of 90% of the vacationer's volume, weighs the same as the
vacationer (to provide a buoyant force equal to her weight). All that remains we see today as a thick atmosphere of heat-trapping carbon dioxide. The Instructors' manuals, allows for a variety of course designs to fit your taste. For example, U-235 has 143
neutrons but only 92 protons. These reactors are simply nuclear furnaces. For more quantitative students, ample end-of-chapter material provides problem-solving activity well beyond the Plug and Chug calculations. The page may be smooth to a radio wave, but to a light wave it is rough. The highest frequency sound humans can hear is about 20,000 meters are simply nuclear furnaces.
Hz. What is the wavelength of sound in air at this frequency? Watch out for remedies to ailments such as baldness, obesity, and cancer; for air-purifying mechanisms; and for "germ-fighting" cleaning products in particular. Salt water? This compaction squeezes much of the water out of the pores between the sediment particles. While doing so, review
in your mind the distinctions among meteoroids, meteors, meteorites, and comets. At that point, is gravity acting on you? A spinning, flattened disk was produced whose mass was concentrated at its hot center. If the input is changed to 12 V, show that the output would be 72 V. Decrease the volume to a third of its original value, and the pressure is
increased by a factor of 3, and so forth (provided the temperature remains the same). (3) After the resin becomes saturated with calcium and magnesium ions, it is no longer effective at softening water. Calling ©t simply t, the time interval, we have Ft = ©(mv). CHAPTER 9 9.7 Generators and Alternating Current 21. What happens to the chemical
identity of a substance during a physical change? Current is therefore induced in the ring, which then establishes its own magnetic field, which always acts in a direction to oppose the field producing it. Only the frequencies of light that match the difference between any two of these permitted energy levels can be absorbed or emitted by an atom. The
fact that birds do catch worms from tree branches seemed to be clear evidence that Earth must be at rest. Now drop the container, and, as it freely falls, note that the world's climate. If the edges and the lines of type fit together, the two pieces of newspaper
must have originally been one. F I G U R E 11. Whether equilibrium is static or dynamic, \boxtimes F = 0. The positions on a standing wave with the largest displacements are known as antinodes. Why will the coin drop into the glass when a force accelerates the card? H2O \leq H2O Water Water OH\geq Hydroxide ion \leq H3O\leq Hydronium ion When a water
molecule gains a hydrogen ion, a second water molecule must lose a hydrogen ion. A 12-V battery moves 4 C of charge from one terminal to the other. 3 Mass—A Measure of Iner tia 1. What naturally occurring element has been contaminating the water supply of Bangladesh? Is it the boiling of the water or the higher temperature of the water that
cooks food faster in a pressure cooker? This causes the sky to appear less blue, with a whitish appearance. Chemists have been able to harness the power of catalysts for numerous beneficial purposes. The orbital velocity of Earth about the Sun is 30 km/s. Rock may not even undergo any chemical changes during recrystallization. In 1935, the death
rate fell to 3 per 100,000. When we speak of the diurnal motion of the stars, we are referring to the motions of celestial objects as a whole; this motion does not change the relative positions of objects. The first four prefixes are mono- (one), di- (two), tri- (three), and tetra- (four). The arts describe these experiences and suggest what may be possible
for us. For the electric dryer of the preceding problem, show that the number of coulombs that flow through in 1 min is approximately 500 C. Would you use a physical model or a conceptual model to describe the following: the brain, the mind, the solar system, the beginning of the universe? Recall that inertia is a term used in mechanics to signify the
resistance of an object to a change in its state of motion. The aluminum cans implode dramatically. (b) = = 0.52 m. Minerals typically have a range of compositions, but that range has fixed limits. When condensation occurs at or near Earth's surface, we call it dew, fog, or frost. 3 E L E C T R I C A L AT T R A C T I O N S B E T W E E N A MO L E C U L
E AND ITS NEIGHBOR Attraction Relative Strength Ion-dipole Dipole-induced dipole Induced dipole Enduced dipole Strongest Weakest Ions and Dipoles Recall from Section 15.7 that a polar molecule is one in which the bonding electrons are unevenly distributed. Note that any location more than 105° from an earthquake's epicenter
does not receive S-waves because the liquid outer core does not transmit S-waves. An important aspect of the Brønsted-Lowry definition is that it uses a behavior to define a substance as an acid or a base. How is this point of view different in science? Seeing the same thing in two opposite directions might imply that the curvature of the universe was
 "closed," much like Earth's surface—if you could see around the world, you might be able to see the back of your head way off in the distance! Astronomers have been looking for such repeating patterns but none have been found, which supports the notion that the universe is "open," expanding in infinite directions. Because a voltmeter is connected
in parallel, its resistance is made very high, so that it draws very little current for its operation. Again rotate the mirrors, and see if your image rotates also. So it makes sense that our observable universe is flat, or quite close to it. In order for something to resonate, it needs both a force to pull it back to its starting position and enough energy to
maintain its vibration. Gravitation acts vertically, which is why the vertical component of velocity changes. For many years, ethanol intended for this purpose was made by fermentation, but today industrial-grade ethanol is more cheaply manufactured from petroleum by-products, such as ethene, as Figure 19.11 illustrates. A rocket initially fired
vertically is intentionally tipped from the vertical course. The proportionality constant k in Coulomb's law of gravitation is tiny. Can you reconcile this with energy conservation? (b) A two-dimensional, crosssectional view of the shells. In any society that thrives more on
capturing attention than on informing, pseudoscience is big business. But in order for the universe to remain static against the inward curvature of gravity, there would need to be another fundamental outward force counteracting gravity. 21.3 Continental Drift—An Idea Before Its Time EXPLAIN THIS H Why do we find coal deposits in frigid
Antarctica? (This is in contrast with the other examples of oxidation-reduction reactions presented in this chapter, which involve the formation of ions from atoms or, conversely, atoms from ions.) This concept is illustrated in Figure 18.36, on the next page, which compares the electronic structures of the combustion starting material, molecular
oxygen, and the combustion product, water. The magnitude of the force does not depend on the sign of the charge. 224 PARTONEPHYSICS FIGURE 9.20 Both the ammeter and the voltmeter are basically galvanometers. This is analogous to three people pulling with equal force on ropes attached to a central ring. If the Styrofoam were outside
the ship, attached below the water line, then the ship would float higher, just as a person would with a life preserver. Again, maximum speed of the boat can be no greater than wind speed. So when new basalt is extruded at the oceanic ridge it is magnetized according to the existing magnetic field. Is concentration typically given with the volume of
solvent or the volume of solution? It also absorbs light reflecting off Earth's surface—a double whammy for further warming. A Ping-Pong ball is 2/40, or 1/20, as massive as a golf ball. An object may store energy by virtue of its position. 41 INTERACTIVE FIGURE Paths of sunlight through the atmosphere. Something quite fascinating happens in this
range. What is the most abundant element for Earth as a whole? If North America and Europe had been stationary, the paths would be the same. In this way, we even out our visual field, which allows us to discern detail in very bright areas and in dark areas as well. A fully dressed person is at rest in the middle of a pond on perfectly frictionless ice
and must get to shore. Why does adding the same amount of heat to two different objects not necessarily produce the same increase in temperature? Use the equation for gravitation to guide your thinking. Half the diameter is half the radius, which corresponds to 4 times as much weight as on Earth. If we consider the components of the weight of an
object rolling down an incline, we can see why its speed depends on the angle. Special coatings on the inner surface of the bulb help to accentuate visible frequencies, which can be seen through the diffraction grating reflection of a compact disc. Suppose you have all the pieces for a game of checkers—12 red pieces and 12 black ones. If a charge q
experiences a force F at some point in space, then the electric field E at that point is E = F/q. In this section, we discuss the physical properties of minerals as expressions of their inner structures. Phenols contain a phenolic group, which consists of a hydroxyl group attached to a benzene ring. He said, "Give me a place to stand, and I will move the
Earth." FYI LEARNING OBJECTIVE Describe efficiency in terms of energy input and output. 226 88 Ra S 89 Ac + - 1e 209 205 4 b. What is the double-bond electrons of the double-bond electrons in most other unsaturated hydrocarbons, the electrons of the double bonds in benzene are not fixed between any two carbon atoms. A ball is thrown
up a mackerel sky. There are five atoms in the methane molecule, CH4. Is this an example of osmosis? Oxygen is the most abundant element in Earth's crust, and silicon is the second most abundant. Once the ball is airborne, and neglecting air resistance, what is the ball's acceleration vertically? Your mass and Earth's mass
 don't change, but the distance between you and Earth's center does change. Cirrus clouds are blown by high winds into their well-known wispy shapes, such as the classic "mare's tail" or "artist's brush." Cirrus clouds usually move across the sky from west to east (with the prevailing winds) and indicate fair weather. You push in one direction and
friction acts in the other direction. Harnessing the wind is most practical when the energy it produces is stored for future use, such as in the form of hydrogen. Wegener supported his hypothesis with impressive geologic, biologic, and climatologic evidence. Then, with a pair of tongs, quickly invert the can into a pan of water. The reason you can't
walk through a wall is because of the repulsions between the electrons 781 F I G U R E 2 8 .1 6 If you move from a distant point down to the surface of Earth, you move in the direction in which the gravitational force acts—toward a location where clocks run more slowly. Astronomers find that light emitted by a particular element at one edge of the
occur between the fundamental units of different substances, such as water and salt. The west-facing side of the mountains helps confine the trapped air (Figure 25.7). The Mid-Atlantic Ridge, for example, was found to wind down the center of the Atlantic Ocean basin 90° W parallel to the American, European, and African coastlines. Most of it is used
for making formaldehyde and acetic acid, important starting materials in the production of plastics. We can't see the farthest star either. Rank the following features of a black hole in order of increasing radius: (a) photon sphere, (b) singularity, and (c) event horizon. If water were most dense at 0°C, it would settle to the bottom of a pond or lake and
inorganic compounds that contain elements necessary for life functions. Atomic number We can think of the mass-per-nucleon graph as an energy valley that starts at hydrogen (the highest point) and slopes steeply to the lowest point (iron), then slopes gradually up to uranium. Half of the remaining carbon-14 atoms will then decay in the following
5730 years, and so forth. Because of the small size of the Moon and tapering of the solar rays, a total solar eclipse occurs only on a small area of Earth. Batteries are either disposable or rechargeable, and here we explore some examples of each. If a chain reaction occurred in a baseball-size chunk of pure U-235, an enormous explosion would result.
LEARNING OBJECTIVE Relate Newton's law of cooling to everyday thermal occurrences. Figure 18.11 shows typical pH values 10 -13 13 Oven cleaner of some familiar solutions, and Figure -14 18.12 shows two common ways of deter10 14 mining pH values. 528 PA R T T H R E E E A R T H S CI E N CE F I G U R E 2 0 .11 The streak test can be used
to identify minerals that have a metallic or semi-metallic or semi-metallic luster. Compare Figure 21.20; can you see that most earthquakes occur at plate boundaries? In each succeeding second time interval is 3 meters. Other friends look
to you for a response. Stream speed can increase with an increase in gradient or a decrease in channel width or depth. If you answered the question, or attempted to, before reading this answer, hooray for you! You're doing more than reading the text—you're learning physical science. he first law of thermodynamics states that energy can be neither
created nor destroyed. (a) Thick zinc walls prevent the battery from overheating. How are most carbonate rocks formed? What impact does beef consumption have on water use? For aluminum, a = 24 * 10-6/°C, and for steel, a = 11 * 10-6/°C. The forces on the hemispheres would have been the same if he had used only one team of horses and tied
the other end of the rope to a tree! 5.6 Atmospheric Pressure How does the weight of air surrounding a planet affect atmospheric pressure at its surface? Scientific models are essentially equivalent to the metaphorical language used in poetry. Push a pin through a small card and place it over the hole of a thread spool. We call the reflection of sound
an echo. Acid A substance that donates hydrogen ions. Does it follow that the impulse the cannon exerts on the can
from the baby. Envision yourself in your chair, then mentally zoom out to see yourself in the room, then in the building, then on the planet. Oxygen, O2, has a boiling point of 90 K (-183°C), and nitrogen, N2, has a boiling point of 90 K (-183°C), and nitrogen, N2, has a boiling point of 77 K (-196°C). The atmosphere contains about 829 billion tons of CO2, most of it from such natural sources as volcanoes.
and decaying organic matter but a growing amount (about 230 billion tons) from human activities. These sorts of reactions within your stomach help you digest your food. If the stream channel changes, discharge increases and stream speed may or may not increase. The Martian atmosphere is about 95% carbon dioxide, with only about 0.15% carbon dioxide, with 0.15% carbon dioxide, with
oxygen. Which produces more cooling: alcohol or the same amount of water on your skin? On a perfect fall day, you are hovering at rest at low altitude in a hot-air balloon. He noted the changing positions of these moons and concluded that they were orbiting Jupiter, which was a violation of the then widely held belief that all heavenly objects orbited
Earth. From this coma arises the tail, which is blown outward by the solar wind. Without the effects of air, a baseball would reach the maximum range when it is batted 45° above the horizontal. Insoluble Not capable of dissolving to any appreciable extent in a given solvent. Radiation from a point source follows an inverse-square law in which the
amount of radiation received is proportional to 1>d 2, where d is distance. (b) Shake with two loops (1 wavelength). Only one additional electron can fit in the valence shell of a hydrogen atom. The following equation, for example, tells us that every 1 mole of methane, CH4, reacts to produce 2 moles of
water, H2O. CHAPTER 4 106. The answer is no. On a playground slide, a child has potential energy in a time of 2 s is 50 W. Likewise, science is unable to answer philosophical questions, such as "What is the
purpose of life?" or religious questions, such as "What is the nature of the human spirit?" Though these questions are valid and may have great importance to us, they rely on subjective personal experience and do not lead to testable hypotheses. Inversions occur in the Los Angeles basin and the Denver basin. The results of these blind experiments
 established beyond any doubt that Mesmer's success was due solely to the power of suggestion. 15.6 Polar Covalent Bonds 17. It was a costly storm, too. Thus, the waveform of any musical sound is no more than a sum of simple sine waves. The remainder of the sludge is hauled off to the landfill or an incinerator. Multiply these quantities of radiation
by the appropriate factor to get the dosages in rems. (Hint: Think about the hammerhead in Figure 2.2.) 96. Interference A property of all types of waves; a result of superimposing different waves, often of the same wavelength. I was unaware at the time that I was discussing physics. A beam of light consists of sillions of small, discrete packets of
energy. As soon as you ignite the nut with a match, place the can of water above it and record the increase in water temperature once the flame burns out. Its shape is preserved as an impression or cast. The potential constructive possibility is the controlled release of vast amounts of clean energy. As a society, how will we deal with the impending
changes nanotechnology may bring? All main-sequence stars generate energy by the nuclear fusion of hydrogen to helium. If you put your hand directly at the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is visible, watch out! Steam is invisible and is clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the nozzle where no steam is not clear of the 
interestingly enough, employed the concept of zero. Underground pools of volcanically warmed liquid water, however, may harbor microscopic life forms. Add a tablespoon of white vinegar to acidify the solution. Another way to put this is that all atoms that contain 26 protons are, by definition, iron atoms. In winter, heat flows from inside a warm
home to the cold air outside. Sometimes called wood alcohol because it can be obtained from wood, methanol should never be ingested because, in the body, it is metabolized to formaldehyde and formic acid. Bernoulli's principle applies to a smooth, steady flow (called laminar flow) of constant-density fluid. Just remember that loss of electrons is
oxidation, and gain of electrons is reduction. It has full-page answers to all the end-of-chapter material in the text. This supplies the oxygen necessary for continued decomposition of organic matter by oxygen-dependent bacteria, known as aerobic bacteria. Our own star, the Sun, is an ordinary star among more than 100 billion others in an ordinary
galaxy known as the Milky Way galaxy (Figure 27.23). Hewitt 480: (top right) Pearson Education/Pearson Science 480: (bottom) Fotolia 483: John Suchocki/Paul G. This continues all the way to uranium and elements heavier than uranium. Figure 19.1 shows the three hydrocarbons pentane, and neopentane. What is a fossil? A lunar eclipse
occurs when all three are aligned, with Earth between the Sun and the Moon. In the third figure, the lever arm is extended with a pipe to provide more leverage and a greater torque. If the elevator is in free fall, your weight is zero (Figure 4.10). Use the concepts of heat and temperature to explain how bringing water to a boil to make tea is actually a
process that cools the water. (Hint: It forms the basis of all life.) C H Dimethyl ether 55. 122. Radioactive materials are extremely useful in scientific research and industry. 68. Each iron atom has four electrons whose spin magnetism is uncanceled. (a) H H H O N C C H H H H H O C C N H + H O N EDTA 62. At the same time, copper ions are
reduced to metallic copper, which coats the nail. In a circuit consisting of two lamps connected in series, if the current in one lamp is 1 A, what is the current in one lamp? High-silica minerals have lower melting points and do not require very high temperatures to melt. When you push the car, you exert a force on the car. A violent combustion
reaction is the formation of water from hydrogen and oxygen. You toss a tennis ball up and down in front of you as you sit in a jet airplane accelerating down the runway for takeoff. Saturated fats in our diet FYI have long carbon chains that contain single bonds. A substance with a high specific heat capacity, on the other hand, must absorb or give off
large amounts of thermal energy for comparable temperature changes. Astrology is an ancient pseudoscience founded in the belief that the positions of celestial objects influence our physical, mental, and social well-being. Why do farther galaxies recede from us at faster rates? The separated pigments had different colors, which is how this technique
got its name—chroma is Latin for "color." Mixtures need not be colored, however, to be separable by chromatography. Hand her a plastic bag of water and she'll tell you it has weight. This means that each 1-point increase on the scale is equivalent to a 10-fold increase in the amplitude of ground shaking. The 3% excess helium is likely from the fusion
of hydrogen in the stars. Friction is a primary force that sets surface of a massive planet should last longer compared to a minute of time on the surface of a massive planet. 2 The Sun 26. They are all dietary minerals that are essential for good health but that can be
harmful, even lethal, when consumed in excessive amounts. Then warmed air close to the ground rises and is replaced by cooler air that moves in from above the water. A truly educated person is knowledgeable in both the arts and the sciences. We can state a rotational version of Newton's first law (the law of inertia): An object or system of objects
will maintain its angular momentum unless acted upon by an unbalanced external torque. The fluorine atom of Figure 15.5, for example, has one space available in its valence shell for an additional electron. During a summer visit to Cancun, Mexico, you stay in an air-conditioned room. Unmagnetized iron S N Slightly magnetized iron S N Strongly
magnetized iron S N S N When a magnet is broken into two pieces, each piece is an equally strong magnet. Amide An organic molecule containing a carbonyl group, the carbon of which is bonded to a nitrogen atom. The primary fuel for these stars that underwent the supernova was hydrogen, which originated with the Big Bang. (a) A hammer hits a
Sun or the Moon. No, no, no! Although a hydraulic device, like a mechanical lever, can multiply force, it always does so at the expense of distance. By contrast, any material in which charged particles do not easily flow is called an insulator. Early in the 20th century, Danish astronomer Ejnar Hertzsprung and American astronomer Henry Norris
Russell did just this. What does it mean to say that an acid is strong in aqueous solution? Between pairs of them the transfer of an electron through their junction can cause emission of light, as in a light-emitting diode (LED). Midocean ridge Oceanic crust Rift Continental crust (d) C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T
ERIOR Convergent Plate Boundaries, as the name implies, are where plates come together, or converge. The tiny flakes of iron can be removed with a simple magnet. PLUGANDCHUG(FORMULAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAMILIAFAM
aimed far from the black hole is slightly deflected. What percentage of light is transmitted by two ideal Polaroid filters, one on top of the other with their polarization axes aligned? So why doesn't a fire grow brighter and stronger when water is added to it? In your room are things such as tables, chairs, and other people. Think and Rank (Analysis) The
Think and Rank questions ask students to make comparisons of quantities. Its density may therefore be expressed as 1 kg/L and its weight density as 9.8 N/L. Atoms can link together to form a molecule, and a molecule consisting of atoms from different elements is a compound. Eventually the stalemate ends and the front either dissipates or,
depending on conditions aloft, changes into a cold or warm front. When a strong acid is dissolved in water, many ions are generated, as indicated in Figure 18.7. The presence of these ions allows for the flow of a large electric current. Try this: Tie a thread around the middle of a plastic drinking straw and then hang the straw by the thread. In this
way a car moving downhill does work on a car moving uphill. We can direct our attention to the sounds of the various instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the faintest tones from the loudest; we can delight in the intricate interplay of instruments and discern the loudest; we can delight in the intricate interplay of instruments and discern the loudest; we can delight in the intricate interplay of instruments and discern the loudest; we can delight in the intricate interplay of instruments and discern the loudest in the loudest in the loudest instruments and discern the loudest instruments are loudest instruments.
As a result, they cannot react to form product molecules. Although the thermal energy of the liquid would decrease with evaporation, the energy per molecule would not change. And if so, would this be a grand coincidence? FIGURE 18.32 FIGURE 18.33 Rust itself does not harm the iron structures on which it forms. Which contributes more to an
atom's size? This is analogous to a stack of pillows. If all the wind bounces back from the sail, will the craft be set in motion? Organisms have become fossilized in many ways (Figure 20.31). Why is it important that a chemical equation be balanced? C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H ' S I N T E R I O R 577 Forces
CHECKPOINT 1. Figure 15.30 illustrates how polar molecules electrically attract one another and, as a result, are relatively difficult to separate. For many years a method for breaking boulders was putting them in a hot fire and then dousing them with cold water. When a slowly rotating ball of gas in space gravitationally contracts, the result is an
increase in its rate of rotation. Newton ushered in the Age of Reason. Once the ball leaves your hand, only the force of gravity acts, ignoring air resistance. (a) (b) (c) (d) Static charge on the surface of any electrically conducting surface arranges itself such that the electric field inside the conductor cancels to zero. Have you ever poured air from one
 glass to another? Cooling rate and cooling time are not the same thing. Earth is 33% iron. Interestingly, natural gas fields within the United States contain about two-thirds of the world's supply of helium. Local Group Our immediate cluster of galaxies, including the Milky Way, Andromeda, and Trangulum spiral galaxies plus a few dozen smaller
elliptical and irregular galaxies. Today we are making similar decisions about nuclear technology's risks and benefits. The reason we don't feel this weight crushing against our bodies equals that of the surrounding air. The extent of their deflections will then depend on their accelerations, which in turn depend on their accelerations, which in turn depend on their accelerations.
their respective masses. Show that the average speed around the track is 45 m/s. The result is a prompt death. Once you have zoomed fully out, focus on that sensation of bigness. 5m 5m 8000 m 5m CHAPTER 4 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L I T E S Earth is that its surface drops a vertical distance of 5 m for every 8000 m
tangent to the surface (Figure 4.24). If the forks are not adjusted for matched frequencies, the timing of pushes is off, and resonance doesn't occur. As magma crystallizes and the liquid becomes separated from the crystals, the liquid portion of the magma crystallizes and the liquid becomes separated from the crystals, the liquid portion of the magma changes, becoming more silica enriched. The time to reach the wall is half of 0.1 s because of
the round trip (0.05 s to reach the wall and 0.05 s to return). O H C H C C H H OCH3 Cinnamonaldehyde HO Vanillin 504 PA R T T W O CH E M I S T RY O C N Amide group O C OH Carboxyl group OH C OH CARBOX CH3 N,N-diethyl-m-toluamide (DEET) FIGURE 19.22 N,N-diethyl-m-toluamide (DEET) FIGUR
is an example of an amide. Mastering Physics contains: • A library of assignable and automatically graded content, including tutorials, visual activities, end-of-chapter problems, and test bank questions so instructors can create the most effective homework assignments with just a few clicks. The direction in which the disk was spinning became the
direction of the Sun's rotation and the orbits of planets. In general, these mantle rocks behave like an elastic solid. The popcorn in the skillet can represent the alcohol molecules lying on the surface of the tabletop. We see so much granite because it is the most common igneous rock on continental land. Chemistry The study of matter and the
transformations it can undergo. The combined capacity of these salinization plants is about 16 billion liters of water a day. The rock colors of Bryce Canyon National Park in Utah provide a beautiful example of iron oxide stain (Figure 20.27). Matter and energy are greatly compacted within both. Putting more ozone into the atmosphere to replace what
has been destroyed is a bit like throwing more fish into a pool of sharks to replace those fish that have been eaten. Work is done in compressing the air, which, in accord with the first law of thermodynamics, increases its thermal energy. On the flip side, the burning of fossil fuels damages the environment. The red arrows symbolize of carbon dioxide
An iron or electric toaster has a resistance of 15 to 20 \(\frac{1}{3}\). The energy in infrared light becomes thermal energy. The heavy weight is a little less
than the weight of air displaced. What is the charge on the oxygen? When they collide head-on? Although each oxygen atom in the molecule has a fairly strong electronegativity, the four bonding electronegativity, the four bonding electronegativity, the four bonding electronegativity.
25.10). The unequal heating of Earth's surface causes air motion. In 2006 Pluto was officially classified as a dwarf planet. The smaller the electronic circuit, the more hazardous are sparks that may short-circuit the circuit elements. CHECKPOINT What is the major difference between fog and a cloud? Insects in the Antarctic ice pump their bodies full
of antifreeze to ward off becoming frozen solid. 7 Polarization see. Highfrequency blue light is scattered all along the path of sunlight, so the long path at sunrise or sunset finds much blue missing. In a cold front, warm, moist air is forced upward more quickly by the advancing cold air. Is chemistry the study of submicroscopic, microscopic,
macroscopic, or all three? What happens to the volume of a loaf of bread when it is squeezed? For example, they will incorporate passive safety measures that cause the reactor to shut down by itself in the event of an emergency. How does an electrically polarized object? The elements copper, Cu; silver, Ag
and gold, Au, are three of the few metals that can be found naturally in their elemental state. They eventually break down and eject energetic particles and emit high-frequency electromagnetic radiation. If the distinction between momentum and kinetic energy isn't really clear to you, you're in good company. We use the symbol g, rather than a, to
denote that acceleration is due to gravity alone. FIGURE 15.26 The three dipoles of a boron trifluoride molecule oppose one another at 120° angles, which makes the overall molecule nonpolar. (b) When the carbon of a carbonyl group is bonded to at least one hydrogen atom, the result is an aldehyde. SAM PLE PROBLEM 2 Solution: (a) The
AMINES Structure H C C H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H H H C H
principal difference between weathering and erosion is that erosion does not occur in place—it involves movement. This page intentionally left blank PARTONE Physics Intriguing! The number of balls released into the array of balls is always the same number emerging from the other side. Sedimentation The stage of sedimentary rock formation in
 which deposited sediments accumulate and change (lithify) into sedimentary rock through the processes of compaction and, usually, cementation. Their approximate distributions are shown in Figure 27.35. All the oxygen in water is bound to hydrogen atoms to make water molecules. When researchers found 2 3 H 2H He 1 n 3.26 MeV that theory
temperature inside an exploding atomic bomb is four to five times 1 2 1 0 the temperature at the center of the Sun, the thermonuclear bomb was but a Energy step away. Cirrostratus clouds are thin and sheetlike, and they often cover the entire sky. 432 PA R T T W O CH E M I S T RY A carbon atom, therefore, is about 12 32 as massive as an oxyge
molecule. 27. Heat is added to the air in the balloon to make it rise, and the air inside the balloon is allowed to cool to make it descend. According to general relativity, which of the two brothers is now younger than the other? On cold winter nights in days past, it was common to bring a hot object to bed with you. Sometimes you hear someone say
that a particular appliance "uses up" electricity. When a ball rolls up an inclined plane, it loses speed because of gravity. It is an absence of matter; it is a condition of nothingness. 11.6 Dispersion EXPLAIN THIS Why can't you ever catch a rainbow? (b) The radius of the track is 100 m and the time to complete a lap is 14 s. 6.9 Expansion of Water 28
FYI F I G U R E 7. An industrial reverse osmosis unit consists of many semipermeable membranes packed around highly pressurized salt water. Although no slug emerged from the gun, exhaust gases did—enough to be lethal. Torques are intuitively familiar to youngsters playing on a seesaw. FIGURE 5.25 A simple mercury barometer. Which is
greater: an increase in temperature of 1°C or an increase of 1°F? Lithification occurs through the processes of compaction and, usually, cementation. 724 PA R T F O U R ASTRONOMY FIGURE 26.26 Edwin E. How do hydrofoils and airplanes attain lift? Hewitt 243: Paul G. Although wave speed and wavelength change when undergoing refraction,
frequency remains unchanged. The gray horizon in the foreground of this computer-generated montage is a close-up of Neptune's moon Triton, which has a composition and size similar to those of Pluto. The answer is seismic studies! Information from seismic studies divides the mantle into two portions: the lower mantle and the upper mantle. Why
then do we see the Sun as whitish instead of yellowgreen? The heavier the load or the higher we lift the load, the more work is being done. 25.2 Weather Variables 10. FIGURE 5.37 Internal pressure is greater in slowermoving water in the wide part of the pipe, as evidenced by the more squeezed air bubbles. The dry ocean beds and channels cut from the wide part of the pipe, as evidenced by the more squeezed air bubbles.
                                                                                                                                                                          uish between force and pressure. If the air is expelled downward, the balloon accelerates upward. A 10-kg bag of groceries is tossed onto a table at 3 m/s and slides to a stop in 2 s. As we shall see in Chapter 23, fossils can
 water on Mars indicate a wetter past. The space surrounding all objects with mass is energized with a gravitational field. Distin
indicate where and when sediments were deposited. Whenever work is done, energy changes. 3 FYI C L A S S I F I C AT I O N O F C L A S T I C S E D I M E N TA RY R O C K S Sediment Particle Size Rock COARSE Boulder 256 mm Gravel e Cobble Conglomerate 64 mm Pebble 2 mm Sand Sandstone 0.062 mm Silt Mud c Siltstone 0.0039 mm Clay
Mudstone Shale FINE Classifying Sedimentary Rocks Sedimentary rocks are divided into two groups, based on the kinds of sediments they contain: clastic and chemical. **The amount of radiant energy Q emitted by an object is proportional to the fourth power of the Kelvin temperature T: Q 2 T4 So, whereas a blue-hot star with twice the peak
frequency of a red-hot star has twice the Kelvin temperature, it emits 16 times as much energy as a same-size red-hot star. F I G U R E 11 .1 2 Marjorie's image is as far behind the mirror as she is in front of it. This magnetism from Earth's geologic past is known as paleomagnetism. Fg R E A D I N E S S A S S U R A N C E T E S T ( R AT ) If you have a
good handle on this chapter, if you really do, then you should be able to score at least 7 out of 10 on this RAT. Body waves (P-waves) or secondary waves (P-wave
grating FIGURE 12.22 INTERACTIVE FIGURE (a) In a spectroscope, light emitted by atoms passes through a narrow slit before being separated into particular frequencies by a prism or (as shown here) a diffraction grating. The three principal lifting mechanisms in the atmosphere are convectional lifting, orographic lifting, and frontal lifting. 4 Al2O3
+ 3 C h 4 Al + 3 CO2 T H I N K A N D R A N K (A N A LY S I S) 45. In the bottom-up approach, nanostructures are pieced together atom by atom. Through a telescope you watch as the probe descends. If a rock contains mineral B (25% silica), which would melt last as temperature increases? The blue arcs indicate negative
charge, and the red arcs indicate positive charge. From such measurements, scientists can inform farmers of the proper amount of fertilizer to use. The wavelength is the distance The human ear can normally hear pitches from sound ranging from about between successive compressions 20 Hz to about 20,000 Hz. As we age, this range shrinks. Some
rocks are strong and some are weak; some rocks are prone to break and others are more likely to flow plastically. Solution = 5 g/10 g/L = 0.5 L SAM PLE PROBLEM 3 At 20C, a saturated solution of sodium chloride in water has a
concentration of about 380 g of sodium chloride per liter of solution. This warmed air blows over the California coastline to produce a relatively warm climate. Every substance (Figure 14.6). Because organic compounds are so closely tied to living organisms shall be a concentration of about 380 g of sodium chloride per liter of solution. This warmed air blows over the California coastline to produce a relatively warm climate.
and because they have many applications—flavorings, fuels, polymers, medicines, agriculture, and more—it is important to have a basic understanding of them. Impulse-momentum relationship: Ft g @(mv) 39. Work = force * distance W = Fd If we lift two loads one story up, we do twice as much work as we do in lifting one load the same distance,
because the force needed to lift twice the weight is twice as much. What do we call minerals that have the same combination of elements but a different arrangement of elements but a different arrangement of elements but a different arrangement of elements that have the same combination of elements but a different arrangement of elements but a different arrangement of elements are the same combination of elements but a different arrangement of elements are the same combination of elements but a different arrangement of elements are the same combination are the same combination are the same combination of elements are the same combination of elements are the same combination 
not occur very frequently (d) no, because it does not contain enough nucleons C H A P T E R 13 347 8. Galaxy Formation We can speculate that when the universe formed, ordinary matter plus an even greater amount of dark matter was produced. An ideal transformer has 50 turns in its primary and 250 turns in its secondary. How much force is
needed to push a nearly weightless but rigid 1-L carton beneath a surface of water? (c) C4H10O. Watch the charged balloon divert the path of sucrose molecules. The hammering jostles the domains so that they can better align with Earth's field.
See Nuclear fission Floodplains, 606-607 Flotation, 125-126 Fluid mechanics, 119-144 Archimedes' principle and, 124, 126 G Galaxies, 754-767 active, 757-760 a
added in 1930—and removed in 2006. How does the speed of the ball's shadow across the field compare with the ball's horizontal component of velocity? The interaction between plate boundaries creates stress, which produces strain in the rock. Likewise, it is a chemical property of water to behave as a base (to accept H+) when mixed with hydrogen
chloride and as an acid (to donate H+) when mixed with ammonia. The interference of light is evident in the bright colors seen in reflections from thin films of gasoline on water. Would it make any noise? These heavy elements are less abundant than the lighter elements because of the brief time available for synthesizing them. Sodium hydroxide,
NaOH, is a strong base, which means that it readily accepts hydrogen ions. universe expand? To accelerate the car, there must be an interaction between the car and something external—for example, you on the outside pushing against the road. Above the Sun's photosphere is a transparent 10,000-km-thick shell called the chromosphere (sphere of
color), seen during an eclipse as a pinkish glow surrounding the eclipsed Sun. Solve for x: SAM PLE PROBLEM 4 So in roughly 5.4 billion years, the Andromeda and Milky Way galaxies will collide. The number of unpaired valence electrons is the same as the number of bonds the atom can form. Describe the process of crystallization. This is true
whether you have 25 coins, 50 coins, or even a million. Rank the following isotopes in order of their radioactive; (a) nickel-59, half-life 4.5 billion years; (b) uranium-225, half-life 4.5 billion years; (c) actinium-225, half-life 10 days. Some facilities, however, are equipped with large furnaces in which dried
sludge is burned, sometimes along with other municipal wastes, such as paper products. Rapid cooling forms a large number of small crystals. (b) electrons. CHAPTER 20 REVIEW 549 FIGURE 20.37 lt Me Co soli oling dif an ica d tio n (Cry sta lliz ati o Heat and pressure Magma (molten rock) ing n) Metamorphic ("changed form") Rock Igneous ("fire-
formed") Rock Sedimentary ("settling") Rock eri ng, transportation, and deposition morphism) (Meta ath an sportation, and deposition morphism) (Meta ath an sportation morphis
may become metamorphic rock; metamorphic rock; metamorphic or sedimentary rocks at Earth's surface may decompose to become sedimentary rock. How might the amount we might absorb through our stomach—after burping? Explain why this never happens. The
catalyst may participate as a reactant, but it is then regenerated as a product and is thus available to catalyze subsequent reactions. Or if the vibration frequency is 3 Hz, then the period is 1 3 s. These fragments are called asteroids ("small star" in Latin). L eft to themselves, objects hotter than their surroundings eventually cool to match the
surrounding temperature. He wrote the work in Latin and completed it in 18 months. Applying pressure to a gas squeezes the gas particles closer together, which decreases the volume. All rights reserved. ** K. The atmosphere really does push with more force against the lower bottom than against the higher top! 131 FIGURE 5.27 FIGURE 5.29
FIGURE 5.28 F L U I D M E CH A N I CS 132 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Characterize pressure changes at various points in a confined fluid. (c) covalent bond. (a) aluminum oxide, because it is a larger molecular interactions (b) NaCl, because it is a solid at room temperature (c) aluminum
oxide, because of the greater charges of the ions and hence the greater force of attraction between them (d) aluminum oxide, because of the covalent bonds within the molecule 4. As the air cools, water molecules move slower and condensation outpaces evaporation. A blue sapphire is a solid solution of trace quantities of light green iron compounds
and blue titanium compounds in aluminum oxide. Water is a good example. (This is because the motor will spin at a low speed and the reverse "generator effect" will be small and allow too great a net current in the motor.) So don't connect a 220-V power saw or any 220-V motor-driven appliance into a 110-V circuit. To understand why, you need to
complete the preceding exercise. Such an arrow drawn to scale and pointing appropriately is called a vector. Interestingly, Earth's interior is kept hot because of nuclear power, which has been with us since time zero. Induced dipole attractions (a) Methane molecules (b) Octane molecules CHECKPOINT What is the distinction
between a dipole-induced dipole attraction and an induced dipole attraction? For all ionic compounds, positive and negative charges must balance. Primary waves are the fastest of all seismic waves and so are the first to register on a seismograph. FIGURE 4.3 As the rocket gets farther from Earth, gravitational strength between the
rocket and Earth decreases. She drops the banana and it falls to the river below. Why is it significantly less costly to purify fresh water through reverse osmosis? Just a few examples are shown in Figure 14.2. Over the course of the past century, we excelled at manipulating atoms and molecules to
create materials to suit our needs. Which should be the stronger acid: water or hypochlorous acid? FIGURE 15.3 Gilbert Newton Lewis (1875–1946) revolutionized chemistry with his theory of chemical bonding, which he published in 1916. The conservation of charge is a cornerstone in physics, ranking with the conservation of energy and momentum
Both pressures are the same. (b) the time during which the multiplied force acts. How it does so is beyond the scope of this book, which will present only this model as is. A greater change in temperature occurs for iron because it has a lower specific heat capacity. Steel, for example, is elastic, but lead and putty are not. The box slides against a
horizontal friction force of 24 N. Most minerals can be identified by their physical properties. (c) 2 moles, This means that its angular momentum at any one time will be the same as at any other time. (55 ml/h) (1 km/0.62 ml) § 89 km/h. (This is like a spilled milkshake, which flows slower than spilled milk.) Basaltic magma is an important example of a
low-silica, fast-flowing magma. See the production of FYI standing waves at http://www2.biglobe.ne.jp/~norimari/science/JavaEd/e-wave4.html. This is evident by its higher temperature. When air resistance is a factor affecting the snowball, does it return to its original level with the same, less, or more KE? (b) 36 N, according to Newton's third law.
Make an educated guess—a hypothesis—to answer the question. 100. For water, this is 2256 J/g (or 540 cal/g). Why can't you move the car by remaining comfortably inside and pushing against the dashboard? This results in two extremely long streams of particles, called jets, extending over 100,000 light-years away from the galactic center, which is
called an active galactic nucleus (AGN). Three principal types of volcanic rocks exist—basalt, and esite, and rhyolite. We talk more about this relationship in the next chapter. When a 1-kg metal pan containing 1 kg of cold water is removed from the refrigerator onto a table, which absorbs more heat from the room: the pan or the water? (a) Fine-
grained rhyolite. However, heating water is one thing; boiling it is another. High, thin cirrus clouds are normally warming clouds: They let sunlight through but are good at trapping terrestrial heat. In a similar fashion, the properties of an element depend on the arrangements of electrons in its atoms TUTORIAL: Bohr's Shell Model 314 PA R T T W O
CH E M I S T RY FIGURE 12.29 (a) A cutaway view of the seven shells, with the number of electrons each shell can hold indicated. F I G U R E B .1 2 Sailboats W I ailors have always known that a sailboat can sail downwind, in the direction Supwind, of the wind. (c) the half-frozen fruit punch is warmer. As the Mass doesn't follow ground motion
energy travels to Earth's surface, the ground shakes and moves. Forces that produce pressures against the sides due to equal depths cancel one another. In general, metals are best stamped or machined to desired dimensions. The negative charge of the carboxylate ion can then pass back and forth between the two oxygens. (c) remains unchanged
On what day was the pond half covered? The gas molecules emit light as they return to an unexcited energy state. The outer planets are larger gaseous planets located much farther away. Recall our example of the weightlifter raising the barbell. (b) Metals can be efficiently extracted from them. In a physics study group, a friend says in a profound
tone that light is the only thing we can see. The fission of a gram of uranium or the fusing of a gram of deuterium? An oxidation-reduction reaction occurs when sodium and chlorine react to form sodium chloride, as shown in Figure 18.18. From 0°C ice to 0°C water, mL, requires 80 cal. Mesmer's reputation was destroyed, and he retired to Austria. A
lunar vehicle is tested on Earth at a speed of 12 km/h. Here we see, dramatically, how pressure is reduced by condensation. Most circuits have more than one device that receives electric energy. One end, called the north-seeking pole, points northward. Because of this stickiness, water has a high boiling point and it effectively excludes less sticky oil
molecules. By how much does the density of air increase when it is compressed to half its volume? Each has its own characteristics. The jovian planets are large, gaseous, low-density worlds with rings. What is its diameter in AU? The formula is MgCl2 (two single negatively charged chlorine ions are needed to balance the one doubly positively
charged magnesium ion). The 50 mL plus 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because, within the mix, many of the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because the smaller BBs are able to fit inside the pockets of space that were empty in the 50 mL do not add up to 100 mL because the smaller BBs are able to fit inside the smaller BBs are abl
together are called component vectors. Low concentration of products, high concentration of reactants Reactants Products, low concentration of products, low concentration of products, low concentration of reactants Products. High concentration of products are called component vectors. Low concentration of products, low concentration of products, low concentration of products.
air. In Figure 4.2, we see that the Moon falls around Earth rather than straight into it. The Fahrenheit scale will become obsolete if and when the United States changes to the metric system. Scams that sell energy-making machines rely on funding from deep pockets and shallow brains! Were these your answers? What happens when hydrogen's
electron gets close to the valence shell of a fluorine atom? Science is a way of knowing about the world and making sense of it. Large rock fragments must have been transported by water currents strong enough to carry them, which indicates dynamic, high-energy environments, such as rapids and fast-moving streams. Amines tend to be basic.
Inertia The property by which objects resist changes in motion. A baseball is batted at an angle into the air. The polar covalent bond with its uneven sharing of electrons and slightly charged atoms is between these two extremes. The Sun is directly in back of you. Smith Project Editor: Chandrika Madhavan Editorial Manager: Laura Kenney Senior
Media Producer: Deb Greco Media Producer: Kate Brayton Executive Manager: Kerry Chapman Associate Director of Production Project Manager: 
quantum hypothesis? If several bulbs are connected in series to a battery, they may feel warm to the touch even though they are not visibly glowing. Relative dating is the ordering of rocks in sequence by their comparative ages. Likewise, the stronger a base, the more readily it accepts hydrogen ions. 5 Dark Energy 28. This very question led to the
idea of the Oort cloud, which provides a continual supply of new comets, replacing those that are destroyed. The implications of petroleum scarcity go far beyond rationing of gasoline for cars or fuel oil for home heating. A gas expands, fills all space available to it, and exerts a pressure against its container. FYI Current = voltage 12 V = resistance
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1000 + 0.012 A voltage 12 V = resistance 100,000 + 0.001 A doubled for a circuit, the current is half what it would have been otherwise. The upward force is the tension in the vine. SAM PLE PROBLEM 2 What is the pH of a solution that has a hydronium-ion concentration of 0.001 M? Magma generated at a divergent boundary is from
the partial melting of mantle rock brought upward with rising convection currents. What is different about them? The prefix mono-, however, is commonly omitted from the beginning of the first word of the name: Carbon and oxygen CO Carbon monoxide CO2 Nitrogen and oxygen Nitrogen dioxide NO2 N2O4 Dinitrogen tetroxide
Sulfur and oxygen Sulfur dioxide SO2 SO3 Sulfur trioxide C H A P T E R 14 E L E M E N T S O F CH E M I S T RY 359 Many compounds are not usually referred to by their systematic names. (c) Why is breakage less likely with a sagging sheet than with a
taut one? From 0.9 = 12 gt 2, t = 0.9 gt 2, t = 0.9 gt 2, t = 0.9 grain and 
seen table salt (halite) under a magnifying glass? When it comes to the history of the universe, we have exactly such a device. Why can 500 mL of sugar water at the same temperature? What do we say of growth that continues in the period of physical maturity? The bending of the wave
(sound or light) is caused by a change of speed.* Figure 11.20 shows a beam of light entering water at the left and exiting at the right. What is the magnitude of the gravitational force between Earth and a 1-kg body at its surface? Furthermore, sodium ions are a vital component of our diet and should never be totally excluded. Now some two hundred
years later, with increased knowledge of magnetism and physiology, hucksters of magnetism are attracting even larger followings. Specific heat capacity is like thermal inertia because it signifies the resistance of a substance to a change in temperature. Most of the helium observed in the universe must have been created elsewhere. Are high-silica
minerals "easier" to melt than those with low silica content? When it decays, it emits a beta particle. Use this relationship to calculate the distance to Alpha Centauri in units of AU: (4.4 [email protected]) a 63,000 AU b = 277,000 AU 1.0 [email protected] if, according to the analogy, 1 AU corresponds to 110 m, then 277,000 AU corresponds to
(277,000 AU)(110 m/1 AU) = 30.5 million m. When atoms combine, there is an energy output, usually in the form of faster-moving atoms and molecules, electrons appear as a cloud
 hovering around the atomic nucleus, but even these models have their limitations. How does the frequency of an electromagnetic wave compare with the system, therefore, can deduce the chemical identity of a compound from its systematic name. Show that the mass of ice
that melts is 11 g. The magnetic field that surrounds a current-carrying wire can be demonstrated by arranging an assortment of compasses around the wire (Figure 9.10). FIGURE 4.36 Pioneer 10, launched from Earth in 1972, passed Pluto in 1984 and is now wandering in our galaxy. The vibrations are displayed on an oscilloscope. We see
electromagnetic induction all around us. We'll soon learn that when a circuit is connected between these terminals, each coulomb of charge in the resulting current is given 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as it passes through the battery (and 12 J of energy as 
City or New Orleans, even when the temperatures are the same. The gain of hydrogen is reduction, while the loss of hydrogen is oxidation. Being less dense than water, oil floats on the surface, where it poses great danger to birds and other wildlife. Pressure is greatest against the bottom of the boulder simply because the bottom of the boulder is
deeper. 726: (bottom) Paul G. Food molecules relinquish their electrons to the oxygen molecules you inhale. FYI LEARNING OBJECTIVE Identify the major properties of the four outer planets: Jupiter, Saturn, Uranus, and Neptune. If we know average speed and travel time, distance traveled is easy to find. Calculate the current in the 240-\( \frac{1}{2} \) filament of
a bulb connected to a 120-V line. Both near and faraway stars appear as if on the inner surface of one great sphere, with us at the center. When quartz breaks, it develops a curved, smooth surface that resembles broken glass—a conchoidal fracture. At noon you're closer to the Sun, so gravitation by the Sun on you is greater. Time = 8
[email protected] distance = speed 2000 km/h (8)(9.46 * 1012 km) = 3.8 * 1010 h 2 * 103 km > h Convert the units from hours to years: = (3.8 * 1010 h) a 1 day 24 h ba 1 yr 365 days b = 4.3 * 106 yr 37. A little thought tells us that the volume of the stone—that is, the amount of space it occupies or its number of cubic centimeters—is equal to the
volume of water displaced. As a result, the waves do not build to great amplitude. Upon losing this hydrogen ion, the central atom of each of these molecules takes on a negative charge. TUTORIAL: What is Chemistry? 18. That's because there is no component of gravitational force acting horizontally. White - cyan = 4. The monomer from which it is
synthesized, ethylene, is an unsaturated hydrocarbon produced in large quantities from petroleum. Rather, because the metal ions are held together by a "fluid" of electrons, these ions can move into various orientations relative to one another, which occurs when a metal is pounded, pulled, or molded into a different shape. Recognize a question or a
puzzle—such as an unexplained observation. (d) The molecular mass also increases. Why does a hot dog pant? At midnight, when the Sun is directly overhead, it pulls on you in a direction opposite to Earth's pull on you. The coin keeps up with you—
 inertia in action! * Copernicus was certainly not the first to think of a Sun-centered solar system. If the temperature of the boiling water is very low, food does not cook at all. A pattern of water waves is produced when it jiggles its legs and bobs up and down (Figure 10.29). Then it returns to the sea, where the cycle continues. (b) black dwarf. (a) (b)
(c) * An electric field is a vector quantity, having both magnitude and direction. on (Lithification) Most minerals (and hence, rocks) are formed by the crystallization of magma. An interesting discovery of nanoscience is that the properties of a material at the level of its atoms can be different from its properties in bulk quantities. Also, the large
meteorite that collided with Earth 65 million years ago causing the mass extinction of the dinosaurs may have been a comet. (a) (b) FIGURE 19.9 The structures for three odoriferous organic compounds that contain one or more benzene rings: toluene, naphthalene, and 1,4-dichlorobenzene. Which person does more work? You see yellow. Gradient
The vertical drop in the elevation of a stream channel divided by the horizontal distance for that drop; the steepness of the slope. (b) objects or systems in uniform motion in a straight line. At the same time, however, it might drastically alter the ocean's ecology. Conversely, at lower temperatures, fewer molecules have sufficient energy to pass over
the barrier. Note that if she falls fast enough so that R = mg, a = 0, so with no acceleration she falls at constant speed. When quartz is the primary mineral, the rock is simply called quartz
sandstone. Wave Speed The speed of periodic wave motion is related to the frequency and wavelength of the waves. 747 748 PA R T F O U R ASTRONOMY F I G U R E 2 7.1 3 The Cat's Eye planetary nebula, seen here with the Hubble Space Telescope, measures about 1.2 light-years across, which is about a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures about 1.2 light-years across, which is about a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures about 1.2 light-years across, which is about a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures about 1.2 light-years across, which is about a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures about 1.2 light-years across, which is about a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures about 1.2 light-years across, which is about a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures across a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures a thousand times the diameter of Neptune's Eye planetary nebula, seen here with the Hubble Space Telescope, measures a thousand times the theory of the Eye planetary nebula, seen here with the Hubble Space Telescope, measures a thousand times the thousand times the theory of the Eye planetary nebula, and the Eye planetary nebula, and the Eye planetary nebula, and the Eye planetary nebula and the Eye planetary nebula and the Eye planetary nebula and the Eye plane
orbit. Vibrations of the cone then produce sound waves in the air. Moving still closer to the front, light to moderate rain or snow develops, and winds become brisk. In terms of the life cycle of the Sun, explain why life on Earth cannot last forever. Grass 67. (Hint: Let the formula Fd = ©KE be your guide to thinking. Only statement (a) is scientific,
NH2 O Hexamethylenediamine Adipic acid H 2O Reactive ends H O N N N O H H O H Nylon FIGURE 19.32 Figure 19.32 shows this process for the condensation polymer called nylon, which was created in 1937 by DuPont chemist Wallace
Carothers (1896–1937). Why is it important that glass mirrors used in astronomical observatories be composed of glass with a low coefficient of expansion? Add food coloring or some salt or both. Comets apparently reside in at least two regions. Experimenters got similar results for pressure. 323 FIGURE 13. Now if you slide the weight farther from
your hand, the twist you feel is greater, although not directly measured, the mantle averages 4.5 g/cm3. In your home, for example, a lamp can be turned on or off without affecting the operation of other lamps or electrical
devices. (After 20 half-lives, the initial quantity of radium-226 will be diminished by a factor of about 1 million.) Half-lives are remarkably constant and not affected by external 1/2 kg conditions. As rising air cools, its capacity for holding water vapor decreases, which increases the relative humidity of the rising air. Hurricanes gain energy from the
heat released by the condensation of water (Chapter 7). Whether the mirror is plane or curved, the eye-brain system cannot ordinarily distinguish between an object and its reflected image. Why doesn't it continue vertically? When more energy is added, the liquid changes to the gaseous phase. (d) One is a solid and the other is a liquid. Why are soap
molecules so attracted to calcium and magnesium ions? What is different about the death rates of people and the "death rates of people and the train slows while the coin is in theat the number of them in any observable A maximum of 200 g of sucrose dissolves in 100 mL of water at 20°C. If the train slows while the coin is in theat the number of them in any observable A maximum of 200 g of sucrose dissolves in 100 mL of water at 20°C. If the train slows while the coin is in theat the number of them in any observable A maximum of 200 g of sucrose dissolves in 100 mL of water at 20°C. If the train slows while the coin is in theat the number of them in any observable A maximum of 200 g of sucrose dissolves in 100 mL of water at 20°C. If the train slows while the coin is in the co
air, the coin lands in front of you. In all known nuclei, the case fission occurs. The dark matter remained diffuse, forming an invisible halo surrounding the newly formed galaxy. The induced electric and magnetic fields are at right angles to each other (Figure 9.36). Most of the current passes along the path of least electrical resistance connecting
these two points. Science is concerned with understanding the physical universe, while religion is concerned with faith in, and the worship of, a supreme being and the creation of human community—not the practice of science. Two powerful guidelines can help you assess physical and chemical changes. If you think scientists know all there is to know
about the universe, think again. What is the acceleration of a mouse that moves across a floor at a constant velocity of 2 m/s? If the train rounds a curve while the coin is in the air, the coin lands off to your side. But air resistance is appreciable, so how do they remain together in fall? In 1705 he was knighted by Queen Anne. Their religious calendar
centered on the roughly 260-day orbit of Venus. Whereas your weight on the surface of the Moon would be much less than it is on Earth, your mass would be the same in both locations. The stars are at different distances from Earth, your mass would be the same in both locations. The stars are at different distances from Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be much less than it is on Earth, your mass would be 
example, carries a charge of 2 + , but the fluoride ion carries a charge of only 1 - . The water is broken up into a multitude of droplets of different sizes when the wave breaks, and like the droplets in the clouds overhead, light of many visible frequencies is scattered to produce the white color. Waves are sent through the wire when the post vibrates.
Cut out one end of a small cardboard box, and cover the end with tissue or wax paper. Neither the researchers nor the participants knew which volunteers wore an ionized bracelet and which wore a placebo bracelet. The ultimate source of energy for wind power, fossil fuels, and biomass is (a) nuclear. At higher temperatures, it is a deep reddish to the contract of t
orange. Matter is made of atoms, and atoms are made of electrons and protons (and neutrons as well). How fascinating it is that our eyes have evolved to have maximum sensitivity in this range. I f you heat a solid sufficiently, it melts and becomes a liquid. What we find is a rift—a growing divide—between those who have a realistic sense of the
capabilities of science and those who do not understand the nature of science, its core concepts, or, worse, feel that scientific knowledge is too complex for them to understand. 310 PA R T T W O CH E M I S T RY FIGURE 12.24 Light source Light beam Light is quantized, which means it consists of a stream of energy packets. In other words, we
cannot simply scale up the atom to a larger size, as we might with a microorganism. Why don't we think the Sun will eventually become a black hole? One molecule that has proved most promising for such molecule that has proved most proved molecule that has proved most proved molecule that has proved molecule that has proved molecu
The resistance of some materials reaches zero at very low temperatures. Explain what is going on from a molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, 17% helium, and 1% methane, ammonia, and other molecular point of view. Jupiter's atmosphere is about 82% hydrogen, and 10% helium, and 10% h
 adding sucrose changes the volume. In recent years, 17 probes have landed on the surface of Venus. Color addition by the mixing of colored lights. The greater the force, the greater your launch speed and the higher your jump. CHAPTER 4 REVIEW 111 FIGURE 4.37 The European-U.S. spacecraft Cassini beams close-up images of Saturn and its
giant moon Titan to Earth. Law of reflection The angle of incidence equals the angle of reflection. He also formulated a theory of the nature of light and showed with prisms that white light is composed of all colors of the rainbow. Discuss whether or not your answer changes if the ice cube contains many grains of heavy sand. (a) The greater the
electronegativity of an atom, the greater its ability to become oxidized. A carbon atom is 12/32, or 3/8, as massive as an oxygen molecule. The Big Bang, however, contained the entire universe. Why are the wingspans of birds a consideration in determining the spacing between parallel wires on power poles? Already our present price system, which is
geared to and in many ways dependent on scarcity, often malfunctions in an environment of abundance. 2 The Elements 12. When seawater in polar regions freezes and the salt is left behind. Recall that with a dying medium-sized star, such as our Sun, contraction continues until gravity is counteracted by the resistance of
electrons. Both will have the same speed. 9 The Transformer—Boosting or Lowering Voltage 9. LEARNING OBJECTIVE Relate conservation of energy to physics and science in general. In part (c), where both bodies have CHAPTER 2 N E W TO N 'S L AW S O F M OT I O N 49 FIGURE 2.21 INTERACTIVE FIGURE The force exerted against the
recoiling cannon is just as great as the force that drives the cannonball along the barrel. This supply of air is obtained by the forward motion of the aircraft, which results from propellers or jets that push air backward. This is the mind-opening art of science, which seeks to learn the nature of the universe for what it is—not for what we might wish it to
be. Which reactant molecules are the first to pass over the energy barrier? a. In a cooling magma, on the other hand, quartz crystallizes after, and at a lower temperature than, feldspar. arth is a dynamic, ever-changing, and active planet. Conservation of Charge Electrons and protons have electric charge. If a pipe effectively extends a wrench handle
to three times its length, by how much will the torque increase for the same applied force? By simple geometry, the Moon's distance of fall per second could be compared with the distance that an apple or anything that far away would fall in one second. λ λ 79. Nanotechnology The manipulation of individual atoms or molecules. The same is true of a
shock wave, which consists of two cones: a high-pressure cone generated at the bow of the supersonic aircraft and a low-pressure cone that follows toward (or at) the tail of the aircraft. The field lines about the proton beam circle in one direction. Any monomer capable of
becoming part of a condensation polymer must have a functional group on each end. Electron-dot structures of elements in the same group have the same group have the same group have the same group on each end. Electron-dot structures of elements in the same group have the same group hav
needed to change a 1-g ice cube at absolute zero ( - 273°C) to 1 g of boiling water is 317 cal. In Chapter 27 we'll explore black holes, which are very, very massive yet quite small. Explosive to drive subcritical piece down barrel to collide with other subcritical piece Radioactive neutron source Barrel Was this your answer? An aneroid barometer
calibrated for altitude is called an altimeter (altitude meter). 552 PARTTHREEEARTHSCIENCETHINKANDSOLVE (MATHEMATICALAPPLICATION) 36. Show that the third dot recedes from the first dot with a speed of 90 mm/s. 420 PARTTWOCHEMISTRY The advantage of tertiary-level treatment is greater
protection of our water resources. (a) Explain why a skydiver who has reached terminal speed is not in free fall. Hydraulic conductivity A measure of the ability of a porous rock or sediment to transmit fluid. The heat of vaporization of ethyl alcohol Lv is about 200 cal/g. T E M P E R AT U R E - D E P E N D E N T S O L U B I L I T Y O F OX YG E N G A
S I N WAT E R AT A P R E S S U R E O F 1 AT M O2 Solubility (g O2 /L H2O) 0.067 0.052 0.044 0.039 0.037 0.033 0.031 Perhaps you have noticed that warm carbonated beverages go flat faster than cold ones. Altostratus clouds often form before a storm. a, 10. The distance traveled is the average speed * time of travel, so a. Some molecules are
broken, and this change alters other molecules, which can be harmful to life processes. The hum heard when a transformer core as their magnetic polarities alternate. This change in wave speed indicates that the inner region of the core must be solid. * The
speed of liquid exiting the hole is 12gh, where h is the depth below the free surface. FYI CHECKPOINT Which carbon-carbon bond was rotated to go from the "before" conformation of light (rather than the generation of heat) occurs, and the glass is transparent. This spreading out helps
accommodate the negative charge. When a molecule consists of only two atoms and the bond—as with Polarity of the molecule is the same as the polarity of the bond—as with Polarity of the bond—as with Polarity of the molecule is the same as the polarity of the bond—as with Polarity of the bond—as with Polarity of the molecule is the same as the polarity of the bond—as with Polarity of the bond by the bond 
about potential dangers of nanotechnology threaten public support for it? After a vigorous shake, observe how the different materials settle. At the ridge crests, gravity gives plates a small push away from divergent boundaries. F I G U R E 1 6 .1 3 Unsaturated solution Saturated solution Saturated solution 50 g sucrose undissolved (a) 150 g sucrose
in 100 mL water at 20°C (b) 200 g sucrose in 100 mL water at 20°C (c) 250 g sucrose in 100 mL water at 20°C (c) 250 g sucrose in 100 mL water at 20°C (d) 250 g sucrose in 100 mL water at 20°C (e) 250 g sucrose in 100 mL water at 20°C (e) 250 g sucrose in 100 mL water at 20°C (e) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 250 g sucrose in 100 mL water at 20°C (f) 25
example, a sucrose-water solution may have a concentration of 1 g of sucrose for every liter of solution. The word thermodynamics stems from Greek words meaning "movement of heat." The pot on the left contains 1 L of water. not to lose any electrons to form a positive ion. When the chamber is in a strong electric or magnetic field, bending of the
tracks provides information about the charge, mass, and momentum of the particles. At the same time, we can say that each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 2 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 3 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 3 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is therefore oxidized: 3 Na(s) h 2 Na+ + 2e- Oxidation Each electron and is the extension Each electron and is the extension Each electron Each 
radiation emitted by a radioactive substance. Newton's first law of motion Every object continues in a state of motion in a straight line at constant speed, unless acted on by a net force. Yet the energy that has always sustained us has been the energy of nuclear fusion. 18.2 Relative Strengths of Acids and Bases 4. Recall from
Chapter 7 that matter exists in phases. By hitting the haystack instead of the wall, you extend the time during which your momentum is brought to zero. Moving away from the Sun, we have in order: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. The gas that forms beneath the surface of a liquid produces bubbles. In contrast to
the chlorine-containing Saran, fluorinecontaining Saran, fluorine atoms tend not to experience any molecular attractions. The air resistance is negligible for the heavier golf ball, and its acceleration is nearly equal to g. Which is closest to the Sun? A skillet is lined with a thin layer of cooking oil followed by a layer of
unpopped popcorn kernels. (d) all of these 10. In an ideal machine, where no energy is transformed into thermal energy, workinput = workoutput into a machine that is converted into useful work output: Efficiency = useful energy output total energy input (More generally,
efficiency is useful energy output divided by total energy input.) Elastic collision A collision in which colliding objects rebound without lasting deformation or the generation of heat. This is why most pH meters need to be adjusted for the temperature of the solution being measured. Mountains in North America matched up with mountains in Europe
and mountains in South America matched up with those in LEARNING OBJECTIVE Describe, and give examples of, the evidence Alfred Wegener used to support his hypothesis of continental drift. Neutron star A small, extremely dense star composed of tightly packed neutrons formed by the welding of protons and electrons. For this reason, the largent and mountains in South America matched up with those in LEARNING OBJECTIVE Describe, and give examples of, the evidence Alfred Wegener used to support his hypothesis of continental drift.
hydrocarbons condense readily at high temperatures and so are found at the bottom of the tower. This monthly rate of spin matches the rate at which the Moon revolves about Earth. Continental crust is between 20 and 60 km thick and composed of less dense granitic rocks. LEARNING OBJECTIVE Discuss the significance of the presence of dark
energy. Compressive stresses push rocks together. Any hydrogen atoms bonded to the carbons are also typically not shown. Bronco dives from a hovering helicopter and finds his momentum increasing. Bottoms up! 398 PA R T T W O CH E M I S T RY The toxicity of any subFYI stance is in the dose. In practice, every gas converts to a liquid before
becoming this cold. Seawater is a mixture of water and a variety of compounds, mostly sodium chloride. Similarly, you don't notice that the air around you has weight. The hulls of racing boats are shaped to minimize this resistive force, which is the principal deterrent to high speeds. F I G U R E 1 7.1 The number of balls in a given mass of Ping-Pong
balls is very different from the number of balls. 110 PARTONEPHYSICSTABLE4. You'll see that the coin drops into the glass. From Q = cm©T we divide by m and get Q/m = c©T = (800 J/kg # °C) * (500°C) = 400,000 J/kg. They also allow us the sense of touch. So projected upward, the dropped one hits first;
downward, the fired one hits first. Earth takes 365.25 days to revolve around the Sun. These divergent rays appear to Mirror emanate from behind the mirror (dashed lines). The surface of Earth, by comparison, is relatively cool, and so the radiant energy it emits has a frequency lower than that of visible light. Because they are both fluids we find that
they obey similar mechanical laws. Endothermic reactions, therefore, can progress from reactants to products only with the continual input of energy. FYI 228 PA R T O N E P H Y S I CS LEARNING OBJECTIVE Describe how electromagnetic induction produces the ac of generators. Light is reflected from objects in a manner similar to the way sound
is "reflected" from a tuning fork when another tuning fork when another tuning fork nearby sets it into vibration. The boiling point of 1,4-butanediol is 230°C. CHECKPOINT Which would be more effective in heating radiator painted black or silver? The time during which production rates rise is approximately equal to the time during which these
rates fall to zero or near zero. The energy of the lightning or electrostatic sparks passing through the air converts oxygen molecules into ozone molecules. A network of reverse osmosis units operating parallel to one another can produce enormous volumes of fresh water from salt water. Does the solution become more or less acidic? Amines are
typically alkaline because the nitrogen atom readily accepts a hydrogen ion from water, as Figure 19.17 illustrates. FIGURE 9.7 A microscopic view of magnetic domains in a crystal of iron. When it is cooled? A hydraulic device multiplies force by 100. Which one? Hammel (Space Science Institute), and K. Rank, from beginning to end, the stages in the
formation of a warm front: (a) light to moderate rain and wind, (b) air warms and rain turns to drizzle, (c) cirrus cloud formation, (d) altocumulus and altostratus clouds darken the sky. Electronegativity is greatest for elements at the lower left. So the revolution of Earth causes the Sun to
 appear to move backward across the sky. By adding various amounts of red, green, and blue, the colors to which each of our three types of cones are sensitive, we can produce any color in the spectrum. Just as a coin falls faster than a feather through air, the heavier person falls faster and reaches a higher terminal speed. The present-day ocean
O C Hydrogen ion O C C H A P T E R 19 O R G A N I C CO M P O U N D S 505 FIGURE 19.24 Carboxyl group and a phenolic group (a) Salicylic acid, which is found in the bark of willow trees, is an example of a molecule that contains both a carboxyl group and a phenolic group. (b) 5 m below that line. For example, the excess carbon dioxide would
lower the pH of the ocean. When the pump handle is pushed down and the piston is raised, air in the pipe is "thinned" as it expands to fill a larger volume. CHAPTER 2 REVIEW 59 90. How strongly an atom is able to tug on bonding electrons has been measured experimentally and quantified as the atom's electronegativity. If the number of data points
were decreased, would accuracy also decrease? So if the little fish approaches the big fish at 1 kg 5 m/s, the momentum after lunch will be zero. Nevertheless, as Figure 18.17 shows, the concentration of atmospheric CO2 is increasing. 500 N 400 N 45. The friction of both liquids and gases sliding over one another is called viscosity and is a
property of all fluids. The same principle explains why igloos, arctic dwellings built from compacted snow, can shield their inhabitants from the cold. What can you do to minimize your exposure to radiation? Might the surrounding negatively charged electrons cause the alpha particle to slow down? What is happening to the spaceship? It is very hot—
more than 15,000,000 K. Another aldehyde, vanillin, which was introduced at the beginning of this chapter, is the key flavoring molecule derived from seed pods of the vanilla orchid. Then the old saying "What goes up must come down" would hold true, just as surely as a stone tossed skyward is returned by gravity (unless, as we shall see, its speed is
great enough). In what alignment of the Sun, the Moon, and Earth does a lunar eclipse occur? Just as Wegener's hypothesis was supported by evidence in different disciplines. Electromagnetic waves would not exist. Two—one from each participating atom.
 4.2 Gravity and Distance: The Inverse-Square Law 6. How many liters of solution does she end up with? 3 3 Material falling into the supermassive black hole in the center of M87 generates powerful jets that shoot out at near light speed. The members of an orchestra tune up their instruments by listening for beats between their instruments and a
rock suspended by a weighing scale weighs 15 N out of water and 10 N when submerged in water. The answer is a resounding yes. Thus, what mass a nucleon has depends on where the nucleon is. 1 P L A N E TA RY DATA Mean Distance from Sun (Earth g 1) (km)
1,392,000 0.39 0.24 Mass 4,880 109.1 (kg) (Earth g 1) 1.99 * 1030 3.3 * 1023 0.06 24 Density (g/cm3) Inclination to Ecliptic 1.41 5.4 7.0° Venus 0.72 0.62 12,100 0.95 4.9 * 10 0.81 5.2 3.4° Earth 1.00 1.00 12,760 1.00 6.0 * 1024 1.00 5.5 0.0° Mars Jovian 1.52 1.88 6,800 0.53 6.4 * 1023 0.11 3.9 1.9° Jupiter 5.20 11.86 142,800 11.19
SCIENCE The Scale of the Solar System Astronomical distances are mindboggling. The same sort of destruction would occur to your own stomach proteins, as well as various tissues, upon ingesting the isopropyl alcohol. At this farthest point from the planet (apogee), the gravitational force is somewhat weaker but perpendicular to the satellite's
motion, and component f has reduced to zero. 562 PARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEA
the atomic number has increased by 1 in this process, the mass number (protons + neutrons) remains the same. Some of these components burn more efficiently than others in a car engine. Black shale is commercially important because it is the main source rock from which crude oil formed. He remained healthy in body and mind into old age.
Newton knew that if a cannonball were fired from a tall mountain, gravity would change its speed all along its trajectory (see Figure 4.27). The wall is too rigid to shake, so the waves are reflected back along the rope. Unlike CO2, which lingers in the atmosphere for decades, soot lingers for only a few weeks before being washed out. Consult Table
17.1 for bond energies. The transformer steps up voltage by a factor 36/6 = 6. Likewise for the universe: what we observe within our own corner of the universe appears to be flat, in a fourdimensional sort of way. Galaxies are calculated to have much more mass than can be seen with the telescope. In scientific notation, k = 9.0 * 109 N \# m^2/C 2. You
have made a battery out of a penny! Why is the effect more pronounced when your tongue is wet with salt water? Once these reactants are consumed, the battery can no longer generate electricity. Nitrogen and oxygen, for example, are much more likely to form nitrogen monoxide when the molecules collide in the Less concentrated More
concentrated parallel orientation shown in Figure 17.7. When they collide in the FIGURE 17.1. In a bigger piece, the chain reaction builds up to enormous energies before the neutrons get to the surface and escape (Figure 13.24). Show that the [email protected]/s2 acceleration of the preceding problem can result from a net force of 15 N exerted on
a 3.0-kg cart. Then Bernoulli's equation doesn't apply well. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Applied research that focuses on developing applications of knowledge gained through basic research. This notation is called an electron-dot structure, or sometimes
a Lewis dot symbol (in honor of the American chemist G. LEARNING OBJECTIVE Describe how energy is carried in waves. Reradiated energy from the plant is of long wavelength because the plant has a relatively low temperature. FIGURE 9.29 Voltage As the loop rotates, the magnitude and direction of the induced voltage (and current) change. Such
precipitation is called virga. This is also acceleration, because the velocity of the vehicle is changing. Relative to our galaxy, we might expect the same trend—stars closest to the galactic center should have faster orbital speeds than 55% helium. The hydrogen bond energy, for
example, is 436 kJ/mole. In the next sample problem, force is F, mass is m, and acceleration is a. By what means is heat transferred by convection? As the temperature further increases, molecules break apart (dissociate) into atoms, and acceleration is a. By what means is heat transferred by convection? As the temperature further increases, molecules break apart (dissociate) into atoms, and acceleration is a. By what means is heat transferred by convection? As the temperature further increases, molecules break apart (dissociate) into atoms, and acceleration is a. By what means is heat transferred by convection? As the temperature further increases, molecules break apart (dissociate) into atoms, and acceleration is a. By what means is heat transferred by convection?
an efficient transformer step up energy? When the bags are slung on the outside of a fast-moving car, the water inside is cooled considerably. Plugging the currently accepted value of H into the equation indicates that the "black" you see on the darkest
scenes on a TV screen is simply the color of the tube face itself, which is more a light gray than black. Ask yourself or a classmate what would happen to the pH of this solution if you were to fill the container with plain water. In this chapter, we also speak of "energy conservation." Distinguish between these two usages. Frontal lifting The lifting of one
air mass by another as two air masses converge. Gold, with its large atoms, is soft. The iron brick will cool off quickly, and you'll be cold in the middle of the night. VIDEO: Caution on Handling Electric Wires VIDEO: Birds and HighVoltage Wires F I G U R E 8.1 7 Although the Wimshurst machine can generate thousands of volts, it puts out no more
energy than the work that Jim Stith puts into it by cranking the handle. When she inserts a third Polaroid at an angle between the crossed Polaroids, light is again transmitted (c). So is life rare or common in this universe? 756 PA R T F O U R ASTRONOMY a faint band of light that stretches across the sky. With present-day tools and knowhow,
scientists are reaching further and finding out more about themselves and their environment than people in the past were ever able to do. The Moon similarly revolves about Earth in a flat planar orbit. Meanwhile, Na+ ions from the salt bridge enter the right container to balance the Cl- ions "abandoned" by the Cu2 + ions as the Cu2 + ions pick up
electrons to become metallic copper. Is there enough methane to react with all of the oxygen? (b) heterogeneous mixture because of the dust particles it contains. The ship will establish its vertical position in the water when the net force on it is zero. Mineral deposits rich in valuable metals are economically important. But not so with an iron block
that sinks in the water and is heavier than the water displaced. Each is stimulated only by certain frequencies of light. What they all have in common is that air is made to flow faster over the wing's top surface than under its lower surface. Changes in internal pressure are evident for water containing air bubbles. A detergent is a synthetic soap that
has stronger grease penetration. (c) remains constant. Glass is transparent to visible light waves, but opaque to infrared waves. Physical changes involving the formation or breaking of molecule-tomolecule attractions, therefore, are much safer to perform, which makes them more suitable for an out-of-laboratory activity. Only a small percentage of
the electric energy fed into a common lightbulb is transformed into light. What happens? FIGURE 26.3 (a) The nebula from which the solar system formed was originally a large, diffuse cloud that rotated quite slowly. The foundation of knowledge laid down by basic research frequently leads to useful applications. Along with the Sun itself, the solar
system contains at least eight planets, which are large orbiting bodies massive enough for their gravity to make them spherical but small enough to avoid having nuclear fusion in their cores. If it displaces more, it rises; if it displaces less, it descends. In each case, momentum is transferred from one ball to the other. Ca. When they do react, they form
hydronium and hydroxide ions. Similarly, storing radioactive wastes underground may pose little risk for us today, but for future generations the partial melting of mantle rock, how is most granitic magma produced? (b) 1 mole. Earth's axis
shifted by 25 cm (9.8 in) increasing Earth's rotation, thereby shortening daylength by 1.8 microseconds! Tectonics in action! FYI 580 PARTH SCIENCE EARTHQUAKE MEASUREMENT—MAGNITUDE SCALES Every year, hundreds of thousands of earthquakes occur. It is the obligation of the vendors of nanotechnology to keep
us informed. Whatever the intensity of the electric field about a charged Van de Graaff generator, the electric field inside the dome cancels to zero. The center of the next smaller wave originated when the bug was at the center of the to zero. The center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the bug was at the center of the next smaller wave originated when the next smaller wave or the next smaller wave or the next smaller wave or the next small
temperature. E very material object possesses inertia; how much depends on its amount of matter—the more matter, the more inertia. The slower-moving molecules then start to line up, but as they do so, their vibrations increase. Pressure = weight density * depth = 9800 N/m3 * 220 m = 2,160,000 N/m2 = 2160 kPa. 51. Hewitt 510: (bottom)
Pearson Education/Pearson Science 512: AP 514: Pearson Education/Pearson Science 519: Leslie A. Over time, the ordinary matter becomes concentrated toward the center of this cloud. Entropy is a measure of how energy spreads to disorder in a system. Although its weight may vary with location, it has the same mass everywhere. In this chapter
we see that momentum is unchanged during collisions. If temperature and pressure are high enough, the rock loses pore space as the fluid in the rock is squeezed out. Electrons that make up this current leave terminal of the battery, pass through each of the resistive filaments in the lamps in turn, and then return to the positive terminal
of the battery. 1.0 * 10-7 M, because in pure water [H3O +] = [OH -] 2. Air blowing over the water carries cooler air to the coastal regions. hydrogen bonds with neighboring A solute that has no practical point of saturation in a given solvent is said to sucrose molecules. Turn the air conditioner off altogether to keep ©T small, as in the preceding
answer. PE is relative to the lowest point of the pendulum, when it is vertical. Because the sodium atom has only 11 protons one valence electron to lose, it tends to 10 electrons form the 1 + ion. We can reason this another way by asking which one would hit the ground first if the cannon were pointed at an upward angle. You combine 50 mL of watering the cannon were pointed at an upward angle.
with 50 mL of purified alcohol and get a total of 98 mL of the mixture. If gravity between the Sun and Earth would continue moving in (a) a curved path. About 200 tons of small meteorites strike Earth every day. So, in spite of its enormous mass, the wheel rotates each half revolution with very little power input. The windows
of older passenger trains sometimes break when a high-speed train passes by on the next track. The solvent diethyl ether can be mixed with water but only by shaking the two liquids together. Gem diamonds, for example, are abundant, but the gem diamond industry works hard to maintain the sense of scarcity. Helium is on the far right-hand side of
the periodic table in group 18 because its physical and chemical properties are most similar to those of the other group 18 elements. He is remembered theologically for his many assertions, one of which relates to centuries of human landscape: "Men never do evil so cheerfully and completely as when they do so from religious conviction." FYI
LEARNING OBJECTIVE Describe the application of Archimedes' principle to gases. White dwarf A dying star that has collapsed to the size of Earth and is slowly cooling off; located at the lower left on the H-R diagram. 548 PARTH SCIENCE This appearance results from even greater temperature and pressure conditions than
those that create schist. Show that the water pressure at the base of this dam is 2160 kPa. REVIEW 141 50. When the temperature drops below 12°C, condensation rules and liquid water pressure at the base of this dam is 2160 kPa. REVIEW 141 50. When the temperature drops below 12°C, condensation rules and liquid water pressure at the base of this dam is 2160 kPa. REVIEW 141 50. When the temperature drops below 12°C, condensation rules and liquid water drops below 12°C, condensation rules are rules and liquid water drops below 12°C, condensation rules are rules are rules and liquid water drops below 12°C, condensation rules are rul
2.6 % Sodium 2.8 % Percentages of elements in Earth's crust, by mass. Are the Hawaiian Islands made up primarily of igneous, sedimentary, or metamorphic rock? CHAPTER 7 H E AT T R A N S F E R A N D CH A N G E O F P H A S E 171 F I G U R E 7.1 8 The hole looks perfectly black and indicates a black interior, when in fact the interior has been
a white dwarf causes it to attract matter from surrounding space to form an accretion disk. Speed = = = 231,000 km/s. When a 10-kg block is simultaneously pushed eastward with a force of 20 N and westward with a force of 15 N, the combination of these forces on the block is (a) 35 N west. Distinguish between dc and ac. FIGURE 1.24
INTERACTIVE FIGURE t=5s The rate at which velocity changes each second is the same. In this phase, its dark side faces us and we see darkness. Mercury follows an elliptical path in its orbit about the Sun. Methane Baking soda Copper Reacts with oxygen to form carbon dioxide and water, giving off lots of heat during the reaction. ©t 0.5 s change
of velocity ©v 10 m/s = = = 5 m/s2. Is there more or less resistance in the high-beam filament? Your spacecraft is cruising within a safe orbit around the black hole. When it melts. What is the reason ice is less dense than water? Metals are malleable, which means they can be hammered into different shapes or bent without breaking. Recall from
Section 12.1 that the atom itself is made of mostly empty space, so the best "image" of the inside of an atom would be a picture of nothing. If you haven't done so already, hold a charged balloon up to a thin stream of water from a faucet. The geometric shape of such a universe would be flat. MIX TURES 407 F I G U R E 1 6 .1 8 Glass is frosted by
dissolving its outer surface in hydrofluoric acid. Anette Zetterberg poses an intriguing thermal expansion puzzle on page 162. Temperature has no upper limit. When the hydronium-ion concentration equals 1 mole/L, what is the pH of the solution? Does a battery produce dc or ac? If you have truly mastered a concept, you should be able to explain it
using language that everyone can understand. Rn .. What is the charge on the copper atoms in Cu2O? And doing that work uses energy, which is lost in the form of heat. The part of the ray that penetrates the surface has more vibrations at right angles to the surface (Figure 11.56). That includes energy conservation, which is woven into every branch
of science and supported by countless experiments from the atomic to the cosmic scale. Samples, however, can be "purified" by various methods such as distillation. The mission of astronomy is to learn about the nature and origins of these objects so that we may better understand the natural universe in which we live. Give two examples of a fluid.
The speed of X-rays is c, the speed of light. Mention some of the terms in this chapter and tell how learning to distinguish among them contributes to your understanding. Just as several people can easily hold a hot potato by quickly passing it around, the phenoxide ion can easily hold the negative charge gets passed around. Images around the charge gets passed around.
distance and object distance are the same. 29 Only energy having the frequency of blue light is transmitted; energy of the other frequencies, or of the complementary color yellow, is absorbed and warms the glass. Calculate the quantity of heat absorbed by 20 g of water that warms from 30°C to 90°C. In fields of study where right and wrong are not
so easily established, the pressure to be honest is considerably less. LEARNING OBJECTIVE List three guidelines used to name compounds. ** Weight density is common to the United States Customary System (USCS) units, in which 1 ft3 of fresh water (nearly 7.5 gallons) weighs 62.4 lb. We would end up trading one problem for another. But in their
 profession, they work in an arena that places a high premium on honesty. Research is any activity aimed at the systematic discovery and interpretation of new knowledge. Why does wrapping a bottled beverage in a wet cloth at a picnic often produce a cooler bottle than placing the bottle in a bucket of cold water? The distinction is shown in Figure
 16.8. A homogeneous mixture may be either a solution or a suspension. 2 The Brightness and Color of Stars 27. The orbital periods of comets originating from the Moon when its sunlit side faces Earth. 192 PA R T O N E P H Y S I CS
MICROWAVE OVE N Imagine an enclosure filled with PingPong balls among a few batons, all at rest. Nellie Newton in Figure 7.11 shakes a rope at a low frequency (bottom). The Universal Gravitational Constant, G TUTORIAL: Motion and Gravity TUTORIAL: Orbits and Kepler's Laws The proportionality form of the
energy costs 8¢/kWh. 58. Then rank the buoyant force on a weighted balloon in water, from most to least, when the surface, (b) pushed 1 m beneath the surface, and (c) 2 m beneath the surface, and (c) 2 m beneath the surface, and (d) 2 m beneath the surface, and (e) 3 m beneath the surface, and (e) 2 m beneath the surface, and (e) 3 m beneath the surface, and (e) 4 m beneath the surface, and (e) 5 m beneath the surface, and (e) 5 m beneath the surface, and (e) 6 m beneath the surface, and (e) 8 m beneath the surface, and (e
expansion, a. To get a numerical value we express km in cm; there are 1000 * 100 cm in 1 km, so Time = 5000 km * 1000 cm/m = 200 million years 2.5 cm/yr 37. Your inventor friend proposes a design for cookware that allows boiling to take place at a temperature of less than 100°C so that food can be cooked with the consumption of less
brightness of each lamp in a series circuit when more lamps are added to the circuit? Rank the following hydrocarbons in order of increasing number of hydrogen atoms: Butane 2-Butene (b) (c) 31. Knowing the age and the width, what is the average rate of spreading? During the Archean, Earth cooled to the point where water vapor in the
atmosphere condensed to form rain clouds. Conductor Any material having free charged particles that easily flow through it when an electrical force acts on them. The cloud that you see farther away from the spout is not steam, but condensed water droplets. +1 net charge If the valence shell of an atom is almost filled, that atom attracts electrons
current (dc) An electric current flowing in one direction only. When preparing to undergo a magnetic resonance imaging (MRI) scan, why are patients advised to remove metallic objects such as eyeglasses, watches, jewelry, and cell phones? At what part of its trajectory does the baseball have minimum speed? One of the most celebrated experiments
demonstrating the pressure of the atmosphere was conducted in 1654 by Otto von Guericke, burgermeister of Magdeburg and inventor of the vacuum pump. (e) Two of the above are signs of chemical change. E nergy tends to disperse. Through these interconnections, a certain amount of information is combined and "digested" in your retina. Because
second, and (c) watt-second? So pushing more CO2 into our atmosphere means pushing more of it into our vast oceans. What is the Oort cloud, and what is it noted for? H C C H Acetylene CHECKPOINT Prolonged exposure to benzene increases the risk of developing certain cancers. Because samples of Earth's crust average 2.7 g/cm3, material
below the crust must have much higher densities. However, they will acquaint you with how the system works for many simple compounds consisting of only two elements. So when we speak of such forces in this chapter, we mean the average force. How does it differ from solar radiation? What I will maintain—and maintain vigorously—is that
knowledge is very much more often useful." Think of examples to support this statement. What makes coal exceptional among rocks? But how can this be when we know the temperatures of stars are ultrahot? Interference is a property of all wave motion, whether
 the waves are water waves, sound waves, or light waves. The apex of this cone is at your eye. 15: Shutterstock 16: Sustermans, Justus (1597-1681) 21: Paul G. Cavendish found G by measuring the tiny force between lead masses with an extremely sensitive torsion balance. 8.3 Electric Field 11. The hydrogen bond is a type of (a) ionic bond. This
compound is a cavity-fighting substance added to some toothpastes— sodium fluoride. Power g W work done g time interval t 49. Input distance? (c) the remains of a giant collapsed star. Hewitt 143: Paul G. As a result, the small amount of heat energy available at -196°C is enough to separate them and allow them to enter the gaseous phase. The
same principle applies to a rocket, which continually "recoils" from the ejected exhaust gas. Light from a camera flash weakens with distance in accord with the inverse-square law. Also note that acceleration is not just the change in velocity; it is the change in velocity in velocity; it is the change in velocity in velocity; it is the change in velocity in velocity; it is the change in velocity in velocity; it is the change in velocity in velocity; it is the change in velocity; i
(a) the duration and/or length of travel. 1 Electromagnetic Spectrum 11. CHECKPOINT A basketball coach describes a playing strategy to her team by way of sketches on a game board. The warm drink, therefore, fizzes in your mouth more than the cold one does. (Get this straight before going further!) 3. Ordinary hydrogen is sometimes called a
perfect fuel because of its almost unlimited supply on Earth, and when it burns, harmless water is the product of the combustion. (Seawater is slightly denser, 1.03 kg/L). If you were in a freely falling elevator and you dropped a pencil, it would hover in front of you. The answer is that gravity pulls
straight downward with no component of force acting forward or backward. Now we conclude with discussions of two very broad-reaching and most fascinating topics: cosmology and relativity. Discuss the physics that explains how the girl in Figure 3.29 can jack up a car while applying so little force. They are within the filament to begin with. Use
       periodic table to find the masses of all the atoms in each molecule. Then all three terms have units of pressure. Based on the information given in the following diagrams, which substance has the lower boiling point: one made , or one made from molecule B, ? What two kinds of motion are exhibited by electrons in an atom? Automobile brakes
convert kinetic energy to heat. Muscovite and biotite. Which type does not require high temperature and pressure for its formation? The magnetic field intensity is appreciable for a current-carrying coil that has many loops. Place a quarter and a penny on a table. The crystals are made when water vapor in a cloud condenses directly to the solid form
This results in a temporary hair coloring, which may come off with the next hair washing. The low temperature of this process tends to keep the chemical structure of the coffee solids from changing. VIDEO: Buoyancy of Air the ground when released. 8.7 Electrical Resistance EXPLAIN THIS H What distinguishes a conductor from a superconductor?
28 PA R T O N E P H Y S I CS When the brakes are applied, the vehicle slows. A steel tank of anything weighs more than the air it displaces, so it doesn't rise. How does this compare with the density of water? These photographs are of people very dear to the authors and make Conceptual Physical Science even more our labor of love. As in all
evaporation, the highest-energy molecules escape from the water, and the water left behind is cooled. CHECKPOINT At the instant a cannon fires a cannon ball horizontally over a level range, another cannon ball held at the side of the cannon fires a cannon fires
relative to other episodes in Earth's past. In the flat central plains of the United States, a tornado zone extends from northern Texas through Oklahoma, Kansas, and Missouri, Science author Suzanne Lyons with children Tristan and Simone illustrate complementary colors on page 291. Does a scale read force or pressure? Assume that the volume of the United States, a tornado zone extends from northern Texas through Oklahoma.
this solution is 500 mL. When an object falls in air, the net force of a low-mass star? Glass absorbs ultraviolet. The leaves of a charged electroscope collapse in time. A B C 79. The inner parts of the
ring travel faster than the outer parts, just as any satellite near a planet travels faster than a more distant satellite. A flat mirror is called a plane mirror. For example, communication satellite near a planet travels faster than a more distance over which the
force acts is mv 2/2F. The common atmospheric pollutant nitrogen dioxide, NO2, for example, may transform to nitrogen monoxide and atomic oxygen merely on exposure to sunlight: NO2 + sunlight: NO2 + sunlight: NO2 + sunlight: NO3 + sunligh
energy to pass over the energy barrier, they are the first ones to transform to product molecules. Is the snowfall in Antarctica therefore heavy or light? In terms of impulse and momentum, why do airbags in cars reduce the chances of injury in accidents? When two air masses meet, differences in temperature, moisture, and pressure can cause one air
mass to ride over the other, forming clouds and precipitation. In general, the different magmas occur in different geologic settings. Differences in P- and S-wave propagation through the core are evidence. Meteorologists have a long and remarkable record of saving human lives and reducing property loss. Write a letter to Grandma or Grandpa telling
that Galileo introduced the concepts of acceleration and inertia and was familiar with forces, but he didn't see the connection between these three concepts. The mineral pyroxene contains more silica than olivine. This solution has a hydronium-ion concentration of 103 M, or 1000 moles/L. Recall from earlier chapters the inverse-square law: the
intensity of light diminishes as the reciprocal of the square of the distance from the source. Hewitt 66: Paul G. The strong man hopes to exert enough force on the large piston to raise the 10 kg that rest on the small piston. A balloon that weighs 1 N is suspended in air, drifting neither up nor down. Why aren't the atomic masses listed in the periodic
table whole numbers? When he evacuated the sphere with his vacuum pump, two teams of eight horses each were unable to pull the hemispheres apart. You can check the radon level in your home with a radon detector kit (Figure 13.6). Video Activities In these activities, students answer multiple-choice questions based on the DPOUFOUPG
1BVM)FXJUUT classroom demonstrations. (Note: 1 light-year equals 9.46 * 1012 km.) 36. Susie hammers on a block of wood when she is 85 m from a large brick wall. For each ton produced from ore, about 16,000 kWh of electric energy is required, as much as a typical American household consumes in 18 months. What is the common name for
oxygen oxide? Heating 10 kg of water through the same temperature difference takes 1000 calories, which is [1000 cal(4.18 J/cal)] = 41,800 J, more than ten times for the piece of steel—another reminder that water has a high specific heat capacity. Headlands stick out from the rest of the shoreline, so they receive the full impact of waves. These are
jet contrails—a condensation trail—that form as hot, humid jet exhaust mixes with the cold air surrounding the plane. The situation for a rotating one is more complicated. 400: (a right) Getty Images, Inc. Uranus was unknown to ancient astronomers and not
discovered as a planet until 1781. A mixture of solids and liquids, for example, can be separated using filter paper through which the liquids pass but the solids do not. The number and relative loudness of the partial tones determine the quality of sound associated with the piano. CHAPTER 1 1. C H A P T E R 12 12.1 Atoms Are Ancient and Empty
EXPLAIN THIS If atoms are empty, why can't we walk through walls? (d) only macroscopic phenomena. A geometrical fact about the curvature of 5m FIGURE 4.24 If you throw a stone at any speed, 1 s later it will have fallen 5 m below where it would have been without gravity. He also proposed that the continents broke through Earth's crust like *
One fossil plant assemblage that offers strong support for Wegener's idea is the Glossopteris flora, which was named after the dominant gymnosperm tree found in the prehistoric southern temperate forests of South America. India, Australia, and Antarctica, Someone gives you two sets of coins. In other words, if the greedy kid had a charge of 2.
each positive kid would have a charge of 1 + . Find the change in the force of gravity between two planets when the distance between them is decreased by a factor of 10. Electric charge flows through a circuit. So if two teams of nine horses each could pull the hemispheres apart, then a single team of nine horses could do the same if a tree or some
other strong object held the other end of the rope. Every hue has some complementary color that makes white when added to it. The outer planets, by contrast, consist mainly of hydrogen and helium gas that coalesced in the cold regions of the solar system far from the Sun. Interestingly, an object under the influence of only one force cannot be in
static or dynamic equilibrium. Although we witnessed the supernova in 1987, the light from this explosion took 190,000 years earlier, These oxides indicate an oxygenated depositional environment, where deep water was well mixed with water from near the surface, 222 PA R T O N
EPHYSICS 400 km/h from Shanghai to its distant international airport. 6 Continental Evidence for Plate Tectonics 21. State your answer in years. (1 J is equivalent to 1 N # m, which is equivalent to 1 kg # m2/s2.) 46. The molar mass of carbon, therefore, might also be presented as 12 g/mole, and that of molecular oxygen as 32 g/mole. The
surface of any material, hot or cold, both absorbs and emits radiant energy. Let's begin. This is a concentration of energy, which is counter to energy's natural tendency to disperse. The burning of fossil fuels contributes to SO2 in the air. What is the fundamental source of electromagnetic radiation? Why are seasonal fluctuations in atmospheric CO2
levels much more pronounced in the Northern Hemisphere than in the Southern Hemisphere? Electric Shock The damaging effects of shock are the result of current passing through the human body. Most electric plugs and sockets today are wired with three, instead of two, connections. Density is a ratio of weight or mass per volume, and this ratio is
greater for any amount of lead than for any amount of lead than for any amount of aluminum—see Table 5.1. 3. So why don't you fall through the chair? In order for sucrose to dissolve in water, the water molecules must first O O H H H HOCH2 pull sucrose molecules away from one another. It once had a molten surface, but it cooled too rapidly for the establishment of moving
crustal plates, like those of Earth. Yes; after the initial charge of the battery is spent, recharging occurs as the motor runs, and this energy is from the fuel. The concept of molecules can be used to readily explain so many different phenomena. A second scenario, known as the Big Rip, recognizes that the influence of dark energy may grow stronger
over time (Figure 28.22). So we must do more work against this "back force" to induce more voltage (Figure 9.25). Some bacteria thrive in boiling hot springs as a result of having heat-resistant proteins. (b) of the type of aguatic life it attracts. Most often, but not always, different speeds of airflow over and beneath a wing are enhanced by a
difference in the curvature (camber) of the upper and lower surfaces of the wing. At the anode? In what two ways does sediment turn into sediment 
"force," we imply the total force, or net force, acting on an object. If questions were not asked, then the conclusion that matter is made up of molecules probably would not have been reached. (a) A skydiver encountering no air resistance is in free fall. \boxed{B}F = 0, and the scaffold is in equilibrium. What remains is light of lower frequencies, which accounts
for the reddish color of the Sun at these times. (c) The energy values of an electron occur only where its wave properties have a maximum amplitude. There are eight atoms, one P atom, and four O atoms. Put another way, it takes less time to move seismic waves through a kilometer of hard material than through a kilometer
of soft material. Homogeneous mixture A mixture in which the components are so finely mixed that any one region of the mixture contains the same ratio of substances as any other region. 1 New ton's First Law of Motion 2. Newton's second law (a = F/m) reminds us that greater force acting on greater mass does not result in greater acceleration. It
typically has a base several kilometers in diameter, and it can tower to altitudes up to 12 km. How do they compare when a bow wave is being produced? Instead, it collects at the bottom of the glass, even after stirring. In contrast, as discussed in Section 14.5, there is a change in chemical identity when elements join to form compounds. (Why is this
question a test of reading comprehension as well as a test of physics knowledge?) 98. Of course, there is at least one surface a gecko finds very difficult to climb—Teflon. R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 27.1 Observing the Night Sky 1. Gradebook t Every assignment is graded automatically. All the colors combined
produce white. A, B, C, D. 3.10 The power available in sunlight is about 1 kW/m 2. Hess discovered seafloor spreading. A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 29. And that less net force means less acceleration? CHAPTER 7 H E AT T R A N S F E R A N D CH A N G E O F P H A S E Visible light 169 F I G U R E 7.1 3 Radiation
Intensity INTERACTIVE FIGURE T = 3200 K Peak frequencies T = 2400 K Radiation curves for different temperatures. It can be clear and colorless if it has no impurities, or it can be milky white from tiny fluid inclusions. Why does this activity work better with salt water than with tap water? A B 101. Does breathing cause you to lose or gain weight?
You have probably also heard the term magnitude. For a supergiant star that has collapsed past the neutron star stage, the escape speed increases to the speed of light, which is 300,000 km/s. 3 Radiation 7. Your model of CH2F2 should look like the methane in Figure 15.19b, except that two hydrogen atoms are replaced by two fluorine atoms. If a
diver ascends to the surface too rapidly, the nitrogen bubbles out of the body fluids (much as carbon dioxide bubbles out of a binary star. It does, however, possess mass and so its gravitational effects are quite measurable
These stars clearly do not follow the pattern of the hydrogenburning main-sequence stars. THINKANDSOLVE (MATHEMATICALAPPLICATION) 32. The H-R diagram is a plot of the luminosity versus surface temperature of stars. We call the energy possessed by the charged particle that is due to its location electric potential
energy. Relativity, first postulated by Einstein, is the study of how space, energy, and mass are related to time. They produced a diagram known as the Hertzsprung- Russell diagram, or H-R diagram, which is of key importance in astronomy (Figure 27.10). While the value of g varies slightly in different parts of the world, it is approximately equal to
9.8 m/s2 (32 ft/s2). But increased temperature is not enough to cause rocks to melt, even though the temperature 0 at sufficient depth is actually much hotter than that of magma. Nuclear fission The splitting of the atomic nucleus into two smaller halves. A bulb's brightness depends FYI on how much power it uses. How many molecules are there in
an 18.015-q sample of water, H2O (formula mass q 18.015 amu)? The Moon's shadow has two portions: a dark, central umbra surrounded by the lighter penumbra. Batholiths, the largest plutons, are defined as having more than 100 km2 of surface exposure. (c) They both have the same number of hydrogen atoms. The molecules in box B each consist
of the same atoms and so represent an element. FIGURE 6.9 When you push down on the piston, you do work on the air inside. Oxygen is light enough to rise out of the glass once it is released from the bubbles. Then t = 384,410 km>89 km>h = 4319 h (1 day/24 h) (1 yr/365 days) $$\$$ 0.5 yr. The rock bodies are neither shortened nor extended. Why
don't all municipalities require third-level treatment of wastewater? 55. Find the net force produced by a 30-N force and a 20-N force and a 2
water has very little internal pressure, but the pressure and temperature increase, and the whole mass of viscous magma and overlying rock explodes into dust and rubble. From physics we know that work, which is expended energy, equals force *
distance. F - f Fnet 51. Are astronomers able to point their telescopes in the direction of where the Big Bang occurred? A 13-W CFL is as bright as a 60-W incandescent bulb. How frequently a wave vibrates is altogether different from how fast it moves from one location to another. Distance = 60 km/h * 4 h = 240 km b. Four hundred years ago, people
had difficulty with ideas like these. At this point, according to theory, what remains has infinite density. FIGURE 20.30 Coquina is just one example of a biochemical limestone. C H A P T E R 14 REVIEW 363 A C T I V I T I E S ( H A N D S - O N A P P L I C AT I O N ) 33. Show that the wavelength of the radio waves that are produced is 561 m. Hewitt
349: (top) NASA 349: (bottom) Getty Images, Inc.- Photodisc./Royalty Free 351: (top right) Pearson Education/Pearson Science 352: (top right) Pearson Education/Pearson Science 352: (top left) iStockphoto 352: (top right) Pearson Education/Pearson Education/Pearson
352: (bottom right) Pearson Education/PH College 353: (top left) Steve Allen/Brand X Picture/Jupiter Images PictureArts Corporation 353: (top middle) Eric Schrader/ Pearson Science 353
marbles would be enough to cover the entire land area of the 50 United States to a depth greater than 1.1 km. When the outward and inward forces are equal, they determine the size of the star. † Interestingly enough, the American writer Ralph Waldo Emerson, who lived during the time when the second law of thermodynamics was the new science
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away 1 from the axis, the fold is called an anticline. beginning + final speed 2 m/s + 4 m/s = 2 m/s 2 change in velocity 4 m/s = 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change in velocity 4 m/s - 2 m/s 2 change 
from rest fall in a given time? We became special by showing we're not so special. 3 Continental Drift—An Idea Before Its Time 21. (d) but it can multiply all of these. You will note a slight "electric smell." This is the smell of ozone gas, which is created as the oxygen in the air is zapped with electrical sparks. Then the acceleration of the cannonball
and cannon can be represented in the following way: cannonball: cannon: F = m FIGURE 2.22 The balloon recoils from the escaping air and climbs upward. The flow ceases when both ends reach the same temperature. Every time she pushes the jack handle down 25 cm, the car rises only a hundredth as far but with 100 times the force. The scaffold
was simply a heavy horizontal plank suspended by a pair of ropes. v = fl = (256 Hz)(1.33 m) = 340 m/s. Show that the water pressure on the bottom of the barrel is 9800 N/m2 or, equivalently, 9.8 kPa. 48. 386 PA R T T W O CH E M I S T RY In the first part of this chapter, we talked about how molecules form. Opaque The property of absorbing light
without re-emission (opposite of transparent). These characteristics mean that Saturn would easily float in a bathtub, if the bathtub were large enough. Surrounding moving electric charges are (a) electric fields. (c) small lodestones. Belly-Flop Bernie dives from atop a tall flagpole into a swimming pool below. They are also the source of a battery's
electric energy. CHAPTER 3 A hydrogen economy may likely start with railroad trains rather than automobiles being powered by fuel cells. If it were fired faster, its path would be less curved and it would hit Earth farther away. The air molecules behave like tiny billiard balls, randomly moving and banging against the inner walls, producing a jittery
force that appears to our coarse senses as a steady push. After a day of skiing in the Rocky Mountains, you decide to go indoors to get a warm cup of cocoa. The weightlifter in Figure 3.16 does work in kilojoules. Why do magnets interact with other magnets? Friendship renewed, we continue in our spirited conversations. Big Bang The primordial
creation and expansion of space at the beginning of time. Light travels about a million times faster than sound—hence the delay between what you see and what you hear. Glaciers are formed from the accumulation of recrystallized snow. 1 Material DENSITIES 3 (kg/m) Solids Iridium Osmium Platinum Gold Uranium Lead Silver Copper Iron
Aluminum Ice 22,650 22,610 21,090 19,300 19,050 11,340 10,490 8,920 7,870 2,700 919 Liquids Mercury Glycerin Seawater Water at 4°C Ethyl alcohol Gasoline 13,600 1,260 1,025 1,000 785 680 An important property of a material, whether in the solid, liquid, or gaseous phase, is the measure of compactness: density. So does a shot. What are
three lines of evidence supporting cosmic inflation? Rank the following solutions in order of increasing concentration. Switches A B 2. Both balls, regardless of their masses, would meet the floor at the same time. What is his pitching speed? These are typically produced by local governments in cooperation with local recyling companies. This model is
too simplified to work well for the transition metals of groups 3 through 12, however, or for the inner transition metals. 82 PARTONEPHYSICS.com SUMMARYOFTERMS (KNOWLEDGE) Conservation of energy for machines The work output of any machine cannot exceed
the work input. Lenses on today's commercial cameras are much bigger than pinholes and therefore admit more light in less time—hence the term snapshot. Mantle convection currents move at a leisurely pace, taking hundreds of millions of years to complete one loop. Why the Sky Is Blue Not all colors are the result of the addition or subtraction of
light. How does the weight of a falling body compare with the air resistance it encounters just before it reaches terminal velocity? The dripping water is saturated with dissolved calcite, so the dripping water is saturated with dissolved calcite, so the dripping water is saturated with dissolved calcite.
OBJECTIVE Describe how rocks are never truly destroyed but are recycled. Conversion from ac to dc is accomplished with an electronic device that allows electron flow in one direction only—a diode. The first concept has been previously stated—that all things radiate, and the wavelength of radiation depends on the temperature of the object emitting
the radiation. Obvious changes would occur in the fields of economics and commerce, which would be geared to relative abundance rather than scarcity. Is the resulting deceleration of the bus greater than, less than, or the same as that of the bug? DurPhase at 25°C: solid Phase at 25°C: liquid ing a physical change, a substance changes its Density:
3.5 g/mL Density: 1.0 g/mL phase or some other physical property, but not its chemical composition, as Figure 14.7 shows. Elements in the same period differ from one another by the number of electrons in the outermost shell. The Venusian carbon dioxide cycle, therefore, broke down as the Venusian water was split apart by the Sun's ultraviolet
rays. Assume the top surface of the rug is younger than the lower surface. Your weight depends not only on your mass but also on your distance from the center of Earth. 20.3 Mineral Properties EXPLAIN THIS Why are some out of the machine
already dry and ready for folding. Which contains a mixture? A theory is a comprehensive idea that can be used to explain a broad range ments in liquids and solids? A mixture containing alcohol is heated to the point where the alcohol, some flavoring molecules,
and some water are vaporized. The same effect occurs in Earth's atmosphere, which is transparent to solar radiation. (b) In accord with the impulse on the ball is equal to its change in momentum relationship, the impulse on the ball is equal to its change in momentum. When a can of carbonated soda is opened, much of this carbonic acid quickly transforms back into water and carbonated soda is opened, much of this carbonic acid quickly transforms back into water and carbonated soda is opened, much of this carbonated soda is opened.
dioxide, which quickly bubbles out of solution because of its low solubility. Three kinds of metal wires, (a), (b), and (c), are stretched between distant telephone poles. Both have the same momentum (1 kg * 10 m/s = 2 kg * 5 m/s). There are two compartments in the large central tank to which the orbiter is attached—one filled with liquid hydrogen and
the other filled with liquid oxygen. The energy of earthquakes is described by a magnitude scale. Quite remarkable! The study of various forms of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations in physics—the law of conservation of energy and their transformations has led to one of the greatest generalizations and the greatest generalizations are greatest generalizations.
into another, but the total amount of energy never changes. Pure water contains practically no ions to conduct electricity. The wings of a certain airplane have a total bottom surface area of 100 m2. 3 Protons and Neutrons 12. From Table 23.1, we find uranium-238, 4.5 billion years; and carbon-14, 5760 years. (c) For
ball B, won't the average speed dipping down and up be greater than the average speed of ball A during the same time? A B C A B C D 62. But when melted, it becomes the same to g of water. 1 Conduction 7. There is no appreciable time delay for the flash of light, so the storm is slightly more than 1 km away. Was This Your Answer The formation of
these sugar crystals results in an increase in entropy. O O H OH open O CH 3 N air Benzoic acid diethylamide 55. F I G U R E 9.1 5 Earth's magnetic field deflects the many charged particles that make up cosmic radiation. The net absorption typical of large drops in rain clouds produces the darkness of
the rain clouds. What would be some advantages and disadvantages of this practice? Hewitt 87: Paul G. The sketches are a conceptual model the coach uses to describe a system (the players on the court), with the hope of predicting an outcome (winning the game). How they differ is mainly that gravitation is only attractive, whereas electrical forces
can repel. (a) 2, 3, 1. It is important to understand that the energy released by an exothermic reaction is not created by the evaporation of liquid from the cloth. You need to know the distance the rock penetrates into the ground, or the time it takes
to do so. * Adapted from Voodoo Science: The Road from Foolishness to Fraud, by Robert L. Simply hold this book at arm's length, close your One of the many beauties of physics is the redness of a fully eclipsed Moon—resulting from the refraction of sunsets and sunrises that completely circle the world. Similarly, does a boxer's fist contain force? But
hand her the same bag of water while she's submerged in a swimming pool, and she won't feel the weight. Where did it come from? A battery is made by connecting a metal that tends to lose electrons with another metal that tends to gain electrons. (If you can't whistle, find someone who can.) Next, try the same thing while holding the tube to your
lips. As rock weathers, it also erodes. Add the mixture of sand and salt to some water. Your brother then comes along, examines the inflated balloons, and tells you that the blue balloon is the one containing the cinnamon. FIGURE 6.4 When pressure is held constant, the 1 volume of a gas changes by 273 of its volume at 0°C with each 1°C change in
temperature. Would electromagnetic fields could produce electric fields could produce electric fields could not in turn produce magnetic fields could not in turn produce magnetic fields? If and when the force of air resistance equals the weight of a falling object, acceleration terminates, and the object falls at constant speed (called the terminal speed). Entropy
is merely a measure of the tendency of energy to disperse. O H O H H Cl Water Hypochlorous acid 57. A class of 20 students takes an exam and every student scores 80%. Which of the following diagrams best represents the size of the atomic nucleus relative to the size of the atom? The classification of electromagnetic waves according to frequency,
from radio waves to gamma rays, is the electromagnetic spectrum (Figure 11.3). In the preceding question, we see a reason why all the gas molecules in our room don't suddenly rush to one corner, leaving us sitting in a vacuum and gasping for breath. Over toward the right side of the periodic table, elements of group 16 are known as the chalcogens
("ore-forming" in Greek) because the top two elements of this group, oxygen and sulfur, are so commonly found in ores. F I G U R E 1 2 .1 7 Atoms in a baseball. The cooling cycle of a refrigerator nicely illustrates
these concepts. Venus, however, is a bit closer to the Sun than Earth is. (d) imagination. Which is more polar: a sulfur-bromine (S—Br) bond or a selenium-chlorine (S—Cl) bond? With axes at right angles, no light is transmitted. One kilowatt-hour is the amount of energy transferred in 1 h at the rate of 1 kW. Using equations for problem solving can
be kept to a minimum for nonscience students, since this book treats equations as guides to thinking. Most functional groups are listed in Table 19.1. The remainder of this chapter introduces the classes of organic molecules shown in Table 19.1. The role heteroatoms play in
determining the properties of each class is the underlying theme. Impure The state of a material that is a mixture of more than one element or compound. Worldwide, the nuclear power industries generate about 10,000 tons of radioactive waste each year. Solution: Current = Solution: Curr
draws a current of 12 A when connected to a 120-V circuit? Rotational kinetic energy is then converted to other forms of energy. At any given moment, however, the electron distribution may be somewhat uneven, resulting in a temporary dipole. Check the map shown in Figure 26.33 to see if a solar eclipse is coming to your area soon. Why or why
not? This time, your breath expands as it leaves your mouth. In general, a higher gas pressure above the liquid means more of the gas dissolves. This is like asking which distance is greater: from New York to San Francisco or from San Francis
can be conducted between the electrodes. If a baseball were the size of the Earth, about how large would its atoms be? 19.3 Functional Groups EXPLAIN THIS Why are there so many different organic compounds? These are large molecules that first need to be broken down into simpler molecules, such as monosaccharides, C6H12O6, fatty acids,
C14H28O2; and amino acids, C2H5NO2. Notoriously, Hahn didn't even acknowledge Meitner's role. Just about anything, including you, beach balls, rubber ducks, dust particles, and bacteria, can be found in water. This requires the use of fuel. An octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned an octane rating of 0.0 is arbitrarily assigned to isooctane, and heptane is assigned an octane rating of 0.0 is arbitrarily assigned as a contrarily as a contrarily assigned as a contrarily assigned as a contrarily 
In grandpa's time automobiles were previously manufactured to be as rigid as possible, whereas autos are now designed to crumple upon impact. 15 BC FIGURE 1.2 Does a force keep the cannonball moving after it leaves the cannon? Ice wedging occurs as water seeps into small cracks, freezes, and expands, thereby widening the cracks. What is
released in the formation of a condensation polymer? The hydrocarbon octane, C8H18, has eight carbons per molecule and is a component of gasoline. Large icebergs come from, or calve off of, glaciers on land. You may, like the rocket, find it more fruitful to follow a course that leads to your goal as best plotted from your present position and
circumstances, rather than try to get back on the course you plotted from a previous position, perhaps under different circumstances. As the bubbles rise, they expand rapidly and push water ahead of them. That is, \boxtimes F = 0. Be glad that air is a poor conductor; if it weren't, you'd feel quite chilly on a 20°C (68°F) day! Snow is a poor conductor because
its flakes are formed of crystals that trap air and provide insulation. Energy from thermonuclear fusion tends to contract its matter in an implosion. (a) (b) FIGURE 20.36 Nonfoliated metamorphic rocks: (a) marble and (b) guartzite. The slice of California moving
northwesterly lies on the Pacific Plate, while the rest of California sits on the North American Plate. electric potential energy amount of charge 1 joule 1 coulomb Thus, a 1.5-V battery gives 1.5 J of energy to every 1 C of charge flowing through the battery. The explanation for this involves quantum theory. How is it possible to measure out a specific plate.
number of atoms or molecules? A good thought to start with is the idea that your bare presence and the bare pr
bonded to a saturated carbon. A person has about a 50% chance of surviving a dose of this magnitude received over a short period of time. For continuous flow, a fluid speeds up when it goes from a wide to a narrow part of the pipe. The glare from reflecting surfaces can be dimmed a lot with the use of Polaroid sunglasses. Thus the saying "looking
for the pot of gold at the end of the rainbow" means pursuing something you can never reach. 32. If it doesn't stick, your friend might be right (but not necessarily—there are lots of nonmagnetic materials). A temperature inversion occurs when warmer air overlies cooler air. Also, there is one particular distance from the hole at which light can orbit
in a circle. To obtain permission(s) to use material from this work, please submit a written request to Pearson Education, Inc., Permissions Department, 1900 E. Physical growth stops when physical maturity is reached. Dolphins emit ultrasound and then time its echoes. One end of an adipic acid molecule and one end of a hexamethylenediamine
molecule can be made to react with each other, splitting off a water molecule in the process. Dropping 11,000 m (7 mi) below sea level, the Marianas Trench is the deepest location on Earth's crust. When it is not, the organism soon dies and tends toward disorder. The principle underlying every machine is conservation of energy. Aristotle believed
that natural laws could be understood by logical reasoning. What's different is the torque. Neglect the electrical resistance in the cooling due to expansion, making the air cool at a lesser rate—the moist Cold moist air adiabatic
lapse rate. Because Earth rotates once every 24 hours, the west wall in your room moves in a direction toward you at a linear speed that is probably more than 1000 km/h (the exact speed depends on your latitude). Look carefully at Figure 12.30. The Big Bang theory had predicted that particles known as magnetic monopoles should be abundant in
our current universe. Suppose that three astronauts outside a spaceship decide to play catch. Nevertheless, m©V for the bug is equal to M©v for the bug is equal to M©v for the car! 83. (d) all of these 9. What scientists have discovered, however, is that light waves and light particles complement each other, and that when these two ideas are taken together, they provide a
deeper understanding of light. You're on a rooftop and you throw one ball downward to the ground below and another upward. See also Plate tectonics magnitude of, 580 notable, 581 tsunamis and, 582-583 Eclipses lunar, 727 solar, 727-728 Ecliptic plane, 709 Efficiency, 79-80 El Niño, 677 Elastic collisions, 69 Electric charge, 187-191
conservation of, 188-189 Coulomb's law and, 189-190 magnetic forces and, 222-225 polarization and, 191 static, 189 units of, 190 Electric current, 196-198 alternating, 198, 228 direct, 198 electromagnetic induction and, 227-228 magnetic current, 196-198 alternating, 198, 228 direct, 198 electromagnetic induction and, 227-228 magnetic forces and 227-228 magnet
fields and, 220-222 measurement of, 223-224 physical effects of, 200-202 Electric motors, 224 Electric motors, 224 Electric potential, 193-195 Electric potential energy, 189-190 Electric power, 206, 228-230 Electric shock, 200-202
Electrical resistance, 198-199 Electricity, 186-215 conductors of, 195 Coulomb's law and, 189-191 lightening and, 699 microwaves and, 195 safety fuses and
Electrochemistry, 472-477 Electrodes, 474 Electrodes, 474 Electrolysis, 80, 478-479 Electromagnetic induction, 225-227 Electromagnetic spectrum, 265-266 Electromagnetic waves, 265-266 Electromagnetic waves, 265-266 Electromagnetic waves, 265-266 Electromagnetic waves, 265-266 Electromagnetic induction, 225-227 Electromagnetic spectrum, 265-266 Electromagnetic waves, 265-266 Electromagnetic waves, 265-266 Electromagnetic waves, 265-266 Electromagnetic waves, 265-266 Electromagnetic induction, 225-227 Electromagnetic waves, 265-266 Electromagnetic waves,
369 Electron waves, 311-313 Electron-dot structures, 368-369 Electronegativity, 380 Electronics technology, 189 Elemental formulas, 356 Elements, 296-297, 300-304 INDEX transmutation of, 329-331 vs. FYI CHECKPOINT How many electrons make up a covalent bond? Three times as
far apart? When a ship is empty, its weight is lowest and it displaces the least amount of water and floats higher. For now it will be enough to view images on the tissue or wax paper. Is a chain reaction more likely to occur in two separate pieces of uranium-235 or in the same two pieces stuck together? (d) photovoltaic. (We talked pounds back then,
but here we use the scientific unit of force, the newton—abbreviated N.) Would the gain be exactly 50 N? Leslie's daughters Megan and Emily open the Earth science chapters on page 519. 1 18 4 5 6 7 8 9 Transition metals 10 11 12 C N O Al Si P S No Gacommon Ge As Se names In Sn Sb Te F I G U R E 1 2 .1 3 The common names for various groups
of elements. If the boxer instead moves into the punch to decrease the duration of impact by half, by how much is the force of impact increased? For example, pentane has a boiling point of 36°C, isopentane's boiling point is 30°C, and neopentane's boiling point is 30°C, and neopentane's boiling point is 10°C. From a quarter of a million cloud-chamber tracks photographed on movie film,
Rutherford showed seven examples of atomic transmutation. The trick is to make sure that all cellular processes shut down together. How did our Moon form and how does it go through phases? Can you tell the difference with your eyes closed? This breeding occurs when small amounts of fissionable isotopes are mixed with U-238 in a reactor. By
then an old man broken in health and spirit, he was sentenced to perpetual house arrest. 324 PARTTWOCHEMISTRY FIGURE 13.6 A commercially available radon test kit for the home. Suppose you find that you are off course. Hewitt 598: (top) Coia Hubert/ Shutterstock 598: (bottom) U.S. Geological Survey, Denver 599: (top) Jeff Schultes/
Shutterstock 599: (bottom) Paul G. What is the role of "loose" electrons in heat conductors? Can you think of any useful applications of joules), or megajoules (MJ, millions of joules). What is the principal reason a feather quilt is so warm on a cold winter night? It is the road that
pushes the car along. Doing so produces two main categories: the silicates and the nonsilicates (Figure 20.12). Interestingly, molecules can also become ions. (c) because it is (a) and (b) combined. (d) The reaction should be heated. Water is the primary agent of weathering.
to explain these results. (It is interesting to note that air resistance plays only a small role, since the air resistance acting downward is practically the same for both a slow-moving and a fast-moving bullet.) 111. What do the ions of the following elements have in common: calcium, Ca; chlorine, Cl; chromium, Cr; cobalt, Co; copper, Cu; fluorine, F;
iodine, I; iron, Fe; magnesium, Mg; manganese, Mn; molybdenum, Mo; nickel, Ni; phosphorus, P; potassium, K; selenium, Se; sodium, Na; sulfur, S; zinc, Zn? 370 PA R T T W O CH E M I S T RY +11 Na 11 protons 11 electrons 0 net charge FIGURE 15. This is illustrated in Figure 14.5. In solid matter, such as rock, the attractions between particles are
strong enough to hold all the particles together in some fixed three-dimensional arrangement. 87. C H A P T E R 16 A suspension is a homogeneous mixture in which the different components are in different phases, such as solids in liquids or liquids or liquids in gases. Imagine that you could pull the block diagram apart at the fault, as shown in the lower
drawing. When an object falls downward through the air, the force of friction, air resistance, acts upward. What are the three most common clastic sedimentary rocks? In the second case, the top surface makes up the core—a syncline. In 2010, after nine years of work, a team in Finland recorded a record low of one-billionth of a kelvin (1 picokelvin),
tantalizingly close to the unattainable 0 K. The descending slab is a location of intense metamorphism. Giving the ball more time to change momentum means less force on your hand. What evidence supports the contention that the strong nuclear force is stronger than the electric interaction at short internuclear distances? The speed of light (as we
know from Chapter 11) is 3 * 108 m/s. Figure 11.11 shows only four of the infinite number of points F I G U R E 11.1 0 INTERACTIVE FIGURE on the candle. An example is the reaction used for many of the discussions
earlier in this chapter: N,N + O"O h N"O + N"O The amount of energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed: + 946 KJ + 498 kJ + 1444 kJ The amount of energy released upon the formation of bonds in the reactants break is Type of Bond Number of Moles N,N O"O + 1 + 1 Bond Energy absorbed: + 946 KJ/mole Total energy absorbed: + 946 KJ + 498 kJ/mole Total energy absorbed as the chemical bonds in the reactants break is Type of Bond Number of Moles N,N O"O + 1 + 1 Bond Energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Total energy absorbed as the chemical bonds in the reactants break kJ/mole Energy absorbed as the chemical bonds in the chemical bonds in the chemical bonds in the chemical bonds in the chem
products is Type of Bond Number of Moles N"O 2 Bond Energy Total Energy of the reaction is found by adding the two quantities: Net energy of reaction = energy absorbed + energy released = + 1444 kJ + ( + 1262 kJ) = + 182 kJ The positive sign indicates a net
absorption of energy, meaning the reaction is endothermic. The current in each branch, according to Ohm's law, is equal to voltage/resistance, and because neither voltage nor resistance is affected in the other branches, the current in those branches, the current in those branches, the current in each branch provided in the other branches, the current in those branches, the current in those branches, the current in those branches is unaffected. The addition polymer polytetrafluoroethylene, shown in Figure 19.31, is what you
know as Teflon. Faster currents can carry larger particles. There are limits on the mass that a star can attain. (Are you reading this before you have reasoned answers in your mind? Then, c(100 \text{ g})(T - 25) = c(75 \text{ g})(40 - T) 100T - 2500 = 3000 - 75T T = 31.4^{\circ}C Solution: Here we switch to rock, but the same concept applies. As heat is absorbed by the
solid, its molecules vibrate more and more violently. But with safeguards and well-informed consumers, society has determined that the benefits of electricity outweigh its risks. 25.5 Violent Weather Why do hurricanes form in the tropics, and why do they commonly form between June and November? The boiling points of hydrocarbons are used for
fractional distillation. The principal two flat prongs on an electrical plug are for the current-carrying double wire, one part "live" and the other neutral, while the third round prong is grounded—connected directly to the ground (Figure 8.27). Research is under way to learn how supercritical water might be used to destroy toxic chemicals, such as
chemical warfare agents. FIGURE 10.7 If you vibrate a Ping-Pong paddle in the midst of a lot of Ping-Pong balls, the balls bounce from one another and also vibrate. So a car going 100 km/h. Electrons, however, are invisible to us. Nonferromagnesian silicates do not
contain significant amounts of iron or magnesium; therefore, they generally have relatively low densities and are light in color. Which has the greater density—1 kg of water? In this way, sediments are sorted according to size as they are deposited (Figure 20.26). Earth F I G U R E 2 6 .11 Earth resides on the inner side of the Sun's
habitable zone, which is where conditions are favorable for life as we know it. If the original clump of ordinary and dark matter was just barely spinning, then the stars forming at the center would take on the form of an elliptical galaxy. EDTA is used to help remove the lead ions from people, usually children, suffering from lead poisoning. Periodic
you should be able to score 7 out of 10 on this RAT. How is this similar to what happens when more branches are added to a parallel circuit? Shouldn't the conscience of the consumer and the economic advantages of sustainable practices be sufficient to motivate industries to protect the environment? Such a solution is said to be basic, or sometimes
TWOCHEMISTRY As a battery provides electricity, electrons move from the negative anode to the positive cathode. 2 DENSITYOFVARIOUSMINERALS (g/cm3) Borax Quartz Talc Mica Chromite 1.7 2.65 2.8 3.0 4.6 All silicate minerals have the same fundamental structure of atoms, the silicon-oxygen tetrahedron—four oxygen
atoms joined to one silicon atom (SiO4)4 - . In this way, the overall required impulse is divided into a series of smaller impulses. So the sum of the upward forces supplied by the supporting ropes indeed do add up to our weights plus the weight of the scaffold. FYI F I G U R E 1 0 .1 7 Ryan demonstrates resonance with a pair of tuning forks with
its own inertia and covers equal distances in equal intervals of time (Figure 4.12, right). The life sciences branch into such areas as molecular biology, and ecology. You can find advertisements for a plethora of pseudoscientific products. FIGURE 2.23 The rocket recoils from the "molecular cannonballs" it fires and rises. We don't know
Another difference between Venus and Earth is in how the two planets spin about their axes. This motion is a consequence of the daily counterclockwise rotation of Earth on its axis. We have seven days in a week because ancient Europeans decided to name days after the seven wandering celestial objects they could observe. The electrons, however
fingers. If it displaces exactly its weight, it hovers at constant altitude. The result was the less acidic and more tolerable acetylsalicylic acid, the chemical name for aspirin, shown in Figure 19.24b. If a box of anything is "dropped" from an orbiting space vehicle, it has the same tangential speed as the vehicle and remains in orbit. REVIEW 233 9.9 The
Transformer—Boosting or Lowering Voltage 26. One way to find them is to look for a binary system in which a single luminous star appears to orbit about an invisible companion, as was illustrated in Figure 27.19. An object projected from Earth at a speed greater than 11.2 km/s but less than 42.5 km/s will escape Earth but not the Sun. Wherever
Sara Devo, Andy Frazer, Kenneth French, Marcia Gillette, Chu-Ngi Ho, Frank Lambert, Jeremy Mason, Daniel Predecki, Britt Price, Jeremy Ramsey, Kathryn Rust, William Scott, Anne Marie Sokol, Jason Vohs, Bob Widing, and David Yates. What happens to the air temperature in a valley when dry, cold air blowing across the mountains descends into
the valley? Peter Hopkinson stands astride a large mirror and boosts class interest with this zany demonstration. For more information on the geology, weather, and history of planet Earth, review Chapters 20-25, which discuss Earth science. They sometimes experience "space sickness" until they become accustomed to a state of sustained
weightlessness. H C 

C H H Ethene Just as the body metaboFYI lizes methanol into formaldehyde, HCOH, it metabolizes ethanol into acetaldehyde, CH3COH. C H A P T E R M S (KNOWLEDGE) Addition polymer A polymer formed by the
joining together of monomer units with no atoms being lost as the polymer forms. A racing car travels along a raceway at a constant velocity of 200 km/h. No. Consider this analogy: You are at a bottle cap convention where you hope to sell your bottle caps. Still higher frequencies are measured in gigahertz (GHz), 1 billion vibra- that vibrates. In our
study of science, we are learning about the rules of nature—how one thing is connected to another and how patterns underlie all we see in our surroundings. Dike Laccolith Batholith Coast Range batholith 20.8 Sedimentary Rocks EXPLAIN THIS How does beach sand become rock? Air resistance The force of friction acting on an object due to its
motion in air. In the same way, a solid chunk of iron floats in mercury even though it sinks in water. CHAP TER 26 THE SOL AR SYSTEM 715 FIGURE 26.9 Ec Because the orbit of Earth, they are always near the Sun in our sky. The second is the loss of the planet's magnetosphere. When the rising air cools are the orbit of Earth, they are always near the Sun in our sky.
close to the air's saturation temperature, the condensing moisture forms a cumulus cloud. Rank the following in order of increasing entropy: a deck of playing cards (a) at 45°C, new and unshuffled sitting in a room at 25°C; (b) at 23°C, new and unshuffled sitting in a room at 25°C, used and shuffled sitting in a room at 25°C, used and shuffled sitting in a room at 25°C, used and shuffled sitting in a room at 25°C. Why is
identifying a mineral by its crystal form usually difficult? Explain rocket propulsion in terms of momentum conservation. Why does an atom with few valence electrons rather than gain more? O O OH 

CH3OH O H2SO4 heat OH OH methanol salicylic acid methyl salicylate (wintergreen) There is much more to organic
chemistry than just learning functional groups and their general properties. (CAUTION: Do not try this on your own: if the lead is not hot enough, it will stick to your finger—ouch!) In Chapter 25 we'll discuss the role of thermal energy in climate change. You can continue breaking the pieces in half and never isolate a single pole. (c) 10 times as much
momentum. In contrast with convergence involving two oceanic plates or one continental and one oceanic plates or one continental and one oceanic plates or one continental collisions—but earthquakes are. Suppose the boat and sail are as shown in Figure B.17. Which lightbulb draws the most current? Think and Solve problems, on the
other hand, are standard "mathematical problems," some of which are challenging and go much further in applying math applications to chapter material. The law of angular momentum conservation is seen in the motions of the planets and the shape of the galaxies. Rad A quantity of radiant energy equal to 0.01 J absorbed per kilogram of tissue. (b)
A head-on collision. Molecule An extremely small fundamental structure built of atoms. The fact that your fingers and the wall push on each other is evident in your bent fingers (Figure 2.14). (b) In this photo of the San Andreas Fault, notice the long valley created by many years of rock grinding along the fault. Diamond is a very unusual covalent
compound consisting of carbon atoms covalently bonded to one another in four directions. If you plot the life-cycle stages of average stars on an H-R diagram, they trace a curve similar to the one for our Sun, which is shown in Figure 27.12. Did you ever see castles or the shapes of animals in the clouds? In a temperature inversion, upper regions of
air are warmer than lower regions. Although it may seem like magic, it is no more (or less!) magical than the ability of masses to exert gravitational forces on each other through space. Between the United States and Africa, the Atlantic Ocean is currently about 4830 km or 4.8 * 108 cm wide. This outermost region of the Sun's atmosphere is the
corona, which THE SOL AR SYSTEM 713 FIGURE 26.4 Never directly look at the Sun! Instead, you can get a nice view of the Sun by focusing the image of the Sun from a pair of binoculars onto a white surface. Cold air begins to lift the warm front, forming an occluded front (Figure 25.15d). The faster the object falls, the greater the distance covered
in each successive second. In many rocks you can see mineral crystals. Copper has a low electrical resistance, while a strip of rubber has an enormous resistance. Earth has an abundant supply of liquid water covering about 70% of Earth's surface, while a strip of rubber has an enormous resistance. Earth has an abundant supply of liquid water covering about 70% of Earth's surface, while a strip of rubber has an enormous resistance.
FIGURE 20.20 (a) Mauna Loa, a shield volcano on the island of Hawaii, is the largest volcano on Earth. Typical classroom infrared thermometers operate in the range of about - 30°C to 200°C. A star's age is revealed by its elemental makeup. Applied research Research that focuses on developing applications of knowledge gained through basic
research. It can be difficult, confusing, and frustrating if you're hasty, but with careful effort, it can be comprehensible and rewarding. It is easy to see the main disadvantage of a series circuit: if one device fails, current in the entire circuit ceases. He invented calculus, a very important mathematical tool in science. Why does the surface temperature
rise on a clear, calm night as low cloud cover moves overhead? Toluene, a common solvent used as a paint thinner, is toxic and gives airplane glue its distinctive odor. Acceleration is 10 m/s2, constant, all the way down. Polls show that about half of American adults do not know that it takes one year for Earth to go around the Sun. The theories of
science are not fixed; rather, they undergo change. So by comparing a Cepheid's luminosity with its brightness and plugging this into the inversesquare law, Hubble was able to calculate the distance to any galaxy containing Cepheids. How believable might the technology of 200 years in the future be to us right now? Here's a quick recipe for rock
candy. 7.5 Climate Change and the Greenhouse Effect EXPLAIN THIS Solar short waves Earth F I G U R E 7.1 9 The hot Sun emits short waves, and the cool Earth emits long waves. The accuracy of history books would be assured. This phenomenon is called resonance. Use this formula to show that the acceleration of a cart on
an inclined plane that gains 6.0 m/s each 1.2 s is 5.0 m/s2. Sunspots are relatively cool regions on the solar surface that move with the Sun's rotation and are created by strong magnetic fields. Recall from Section 14.2 that boiling is a process wherein the molecules of a liquid separate from one another as they go into the gaseous phase. But a body of
established knowledge exists that can't be easily overthrown. When we view the light from a glowing element through a spectroscope, we see that the light consists of a number of discrete (separate from one another) frequencies rather than a continuous spectrum like the one shown in Figure 12.22. The cells also produce more than 100 gal of
drinking water for the astronauts during a typical week-long mission. Rock that breaks undergoes brittle deformation; rock that flows has plastic deformation; rock that flows has plastic deformation. So 20 m/s the projectile arrives at its initial level with the same speed it had when it was initially projected. After the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of a nucleus reaches a certain point, the neutrons so outnumber of the size of th
the protons that there are not enough protons in the mix to prevent the neutrons from turning into protons. F I G U R E 1 7.1 5 A catalytic converter reduces the pollution caused by automobile exhaust by converting such harmful combustion products as NO, CO, and hydrocarbons to harmless N2, O2, and CO2. (a) A green ball strikes a yellow ball at
rest. One of them is the apparent bending of a stick that is partially submerged in water. Conglomerates are often found in river channels and along rapidly eroding coastlines. The lowest-frequency sine wave is the fundamental, and it determines the pitch of the note. In other words, polar molecules can be thought of as being "sticky," which is why it
                              FIGURE 15.30 Water molecules attract one another because each contains a slightly positive side and a slightly negative side. So the opposite charge, pressured into motion by voltage and hampered by resistance. Where
might you find the answer? How can this be accomplished? This is also stable air. The expansion occurs because the air moves to a region of lower air pressure. The price of aluminum at that time was about $100,000 per
pound, and it was considered a rare and precious metal. The source of heat of volcanoes and natural hot springs is trace amounts of radioactive minerals in common rock in Earth's interior. The velocity of the ball at any instant is simply Velocity = acceleration * time. This is electrolysis. No. The process of crystallization from magma, not
recrystallization, is the opposite of partial melting. A B C C H A P T E R 10 64. stars per year. We know dark matter is there because of its gravitational effects, but scientists can only guess as to its nature. (b) that produce the sound you hear. This deflecting force is very different from the forces that occur in other interactions, such as the
gravitational forces between masses, the electric forces between masses, the electric forces between magnetic poles. Similarly, a blue piece of glass appears blue because it transmits primarily blue and absorbs the other colors. 2.14 + 0.61 + 0.009 + 0.005 = 2.76 Ice caps and glaciers 2.14/2.76 = 0.77 or 77% Groundwater 0.61/2.76 = 0.22 or
22% Streams, lakes, and rivers 0.009/2.76 = 3.25 * 10-3 or 0.32% Soil moisture 0.005/2.76 = 1.81 * 10-3 or 0.18% 35. From the horse latitudes, surface air moves back toward the equator. Also, in 2005 the EPA implemented the Clean Air Interstate Rule (CAIR), which is designed to reduce levels of these pollutants even further, especially for areas
downwind of heavily industrialized regions. Stay tuned for an exciting new revolution in human capabilities are easy-to-perform, hands-on activities designed to help students experience physical science concepts for themselves. 6.9 Expansion
of Water EXPLAIN THIS Why does ice float? Take this balloon and inflate it to the size of the Sun. Functional group A specific combination of atoms that behaves as a unit in an organic molecule. (a) Before opening her chute, what force of air resistance will she encounter when she reaches terminal velocity? Lights of colors between red and violet
travel at their own respective speeds in glass. The volume of many liquid solvents expands with increasing temperature. (c) wavelength of light. LEARNING OBJECTIVE Describe how interference is a property of all wave behavior. At higher altitudes, they collapse more rapidly. This is a major factor that distinguishes science from nonscience.
Chapter 9 that there have been times when Earth's magnetic field has diminished to zero, only to build up again with the poles reversed. (Only recently have artificial detectors been made with greater sensitivity to light than the human eye.) An image of the visual field outside your eye is spread over the retina. Eventually, a random event, such as the
passing of an asteroid or comet, caused our companion to sway from the Lagrangian point and fall toward and collide with Earth. Would you expect to find more dissolved oxygen in ocean water around the northern latitudes or in ocean water close to the equator? From greatest to least, rank the amount of friction between the crate and the floor. The
an empty large-mouthed jar (for example, a peanut butter jar) with sand, pebbles, coarse gravel, and small Styrofoam pellets (perlite). The lowest speed? (Please read Appendix C, "Exponential Growth and Doubling Time"—very important material.) CHECKPOINT What does it mean to say that the greenhouse effect is like a one-way valve? For the
science student, this same foundation affords a springboard to other sciences such as biology and health-related fields. A falling star is a meteor visible in the sky as it burns in the atmosphere. ** When Thomson became a baron he took his title from the Kelvin River, which ran through his estate. Think and Rank Problems Think and Rank Problems
have been written for every chapter of the Fifth Edition. Two particles have been destroyed at the points where the spirals emanate, and four others created in the collision. The neutron was elusive because of its lack of electric charge. The waves move along, not the water. Mercury is a small planet, with only about 6% of the volume and mass of
Earth. In whatever case, \Theta F = 0. Suppose that one person in the preceding exercise has twice the mass of the other. An object can have PE without being in motion and therefore without having momentum. electric current by rotating a coil within a stationary Transformer A device for transferring electric power from magnetic field. 4 The Life Cycles
of Stars 27. Also because of their similarities, lanthanides are unusually difficult to purify. The exhaust from automobiles today is much cleaner than before the advent of the catalytic converter, but many more cars are on the road. The dashed lines show three circular orbits about Earth. It ended up in rocks! Much of the oxygen released by
photosynthesizing plants dissolved in the oceans, where it reacted with iron to produce layers of iron oxide minerals on the seafloor. u l J. An alcohol does not contain a benzene ring adjacent to the hydroxyl group. Hard water also inhibits the cleansing actions of soaps and, to a lesser extent, detergents. (d) The zinc walls are transformed into zinc
ions as the battery provides electricity. Moving water is deflected by the Coriolis force—to the right in the Northern Hemisphere and to the left in the Southern Hemisphere and to the left in the Southern Hemisphere and to the left in the Southern Hemisphere. An amide is a carbonyl-containing organic molecule in which the carbonyl carbon is bonded to a nitrogen atom. For the lowest-frequency sound, so l = v/f = l = v/f = (340 \text{ m/s})/(20 \text{ m/s})
Hz) = 17 m. They form because groundwater (Chapter 22) picks up calcium and carbonate ions as it moves through limestone formations in a cave. CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY TWO CHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment? 376 PART TWOCHEMISTORY CHECKPOINT Why don't we notice the bending of light by gravity in our everyday environment.
achieved by an outer surface made of an alloy of 77% copper, 12% zinc, 7% manganese, and 4% nickel. 118. (a) C, B = D, A. Low-frequency vibrations produce wavelengths. Which has the greater amount of thermal energy: an iceberg or a cup of hot coffee? W hen
thermal energy transfers as heat, the energy lost in one place is gained in another in accord with conservation of energy. Rock in the continental crust contains more silica than rock in the mantle. Figure 27.8, a photograph of stars taken with the Hubble Telescope, shows this—stars come in every color of the rainbow. Some bottled water is now
advertised as containing extra quantities of "Vitamin O," which is a marketing gimmick for selling oxygen, O2. In what alignment of the Sun, the Moon, and Earth does a solar eclipse occur? Story has it that while they were walking in a garden, she remarked about the beauty and wonder of the stars. (A better name for this type of heater would be a
convector.) Now if you're interested in optimum efficiency, a silver-painted radiator radiates less, becomes and remains hotter, and does a better job of heating the air. What law applies here? Distinguish between weathering and erosion. EXAMPLES 1. H3O ≤ H
calcium carbonate, which is the same chemical found in limestone. As we soon see, it underlies the electromagnetic waves that we call light. C H A P T E R 18 18.3 Acidic, Basic, and Neutral Solutions 7. When the rose is held in white light, the petals appear red and the leaves appear green, because the petals reflect the red part of the white light and
involves inflation. Do the digestion and subsequent metabolism of foods and drugs tend to make the molecules of the following statements of the following statements. Each of the following statements.
describes one or more characteristics of a particular metamorphic rock. The silk hangs on to electrons more tightly than the glass or plastic rod does. FYI 248 PARTONEPHYSICSFIGURE10.18 In 1940, four months after being completed, the Tacoma Narrows Bridge in the state of Washington was destroyed by wind-generated resonance
amide 3. Mathematically, pH is equal to the negative logarithm of the hydronium-ion concentrations, meaning [H3O+] is read "the molar concentration of hydronium ions." For understanding the logarithm function, see
Figuring Physical Science on page 466. As she did so, she would finally reach a point where she would see Earth coming up from the horizon. But the planes are slightly tipped with respect to each other—a 5.2° tilt, as shown in Figure 26.36. To avoid confusing brightness with energy output, astronomers clearly distinguish between apparent
brightness and the more important property, luminosity. Their hot surfaces warm surrounding air by conduction, the warmed convection currents heat the room. The movement of mass on and beneath Earth's rotational velocity must
rise, and if they don't eventually rupture, fabric stretching reaches a maximum and balloons settle where buoyancy matches weight. If it's more than 0.6 m (2 ft), you're exceptional. Directly overhead at the ground surface is the epicenter. But he was passionate about science in general, and shared his passion with many questions as we painted
together. The field plays an intermediate role in the force between bodies. TWOCLASSESOFCHEMICAL REACTIONSYet another way to protect iron and other metals from oxidation is to coat them with a corrosion-resistant metal, such as chromium, platinum, or gold. Which celestial bodies appear fixed relative to one another, and
which celestial bodies appear to move relative to the others? What does this indicate about the age of such stars relative to the age of our Sun? Water seeks its own level. So 1 Calorie is really 1000 calories. In the simple model of the atom proposed in the early 1900s by Ernest Rutherford and Niels Bohr, a positively charged nucleus is surrounded by
negatively charged electrons (Figure 8.2). Hence, it orbits with no change in speed. (a) A normal fault before erosion: (b) the same normal fault after erosion. Be sure you understand this before you study further. You heat the two balloons in a microwave until each inflates to about the size of a grapefruit. Conversely, energy must be extracted from a
substance to change its phase in the direction from gas to liquid to solid (Figure 7.34). If we place another magnetic field. How tall will the wiped area be compared with the vertical dimension of your face? A fire walker must be careful that no iron nails or other good
conductors are among the hot coals. Induced Dipoles In many molecules, the electrons are distributed evenly, and so there is no dipole. Pause to reflect on the physics of sound while you are quietly listening to your radio sometime. Make a pinhole camera, as illustrated. We see a mirage, which is formed by real light and can be photographed (Figure
11.25). FIGURE 20.33 This satellite photo reveals regionalscale folding of metamorphic rocks in the Appalachian Mountains of central Pennsylvania. Which have the longest wavelength: light waves, X-rays, or radio waves? Pennies made before 1982 are pure copper. In the case of the "floating lithosphere," the buoyant force is produced by the
underlying mantle. Part of the energy from the Sun goes into the evaporation of water from the ocean, and part of this returns to Earth in rain that may be trapped behind a dam. Its beautiful pink color, as shown in Figure 26.6, arises from the emission of light from hydrogen atoms. Its temperature rises by only 1°C, because 2 L of water contains the energy from the emission of light from hydrogen atoms. Its temperature rises by only 1°C, because 2 L of water contains atoms.
twice as many molecules, and each molecule receives only half as much energy on the average. Figure 17.11 shows the activation energy in this chemical reaction as a vertical hump. Such observations led Newton to his third law of motion. Although pure quartzite is white, it commonly contains impurities that can cause it to be a variety of colors,
such as pink, green, or light gray. If so, why are you not buoyed up by this force? What is the molarity when water is added to 2 moles of sodium chloride to make 0.5 L of solution? Figure 25.15f shows that all the warm air was forced up and over the steadily advancing cold front. Please be patient with yourself as you find learning the similarities and
                                 pysics concepts is not an easy task. The lower zone of the upper mantle is the plastic asthenosphere. (a) Shale, the most abundant sedimentary rock, is composed of very fine mudsized particles; (b) sandstone is composed of sand-sized particles; and (c) conglomerate is made up of a poorly sorted variety of rounded
mostly gravel sized, but also with sands and muds. FIGURE 27.11 This image of the Trifid Nebula was obtained by the Spitzer Space Telescope. The spheres drawn around these and subsequent illustrations of electron-dot structures indicate the relative sizes of the atoms and ions. Most carbonate rocks originate biologically as a result of shell
growth. Smash a few of these salt cubes, and then look at them again carefully. What are solar and lunar eclipses and why are they rare? 81. 18.6 Harnessing the Energy of Flowing Electrons EXPLAIN THIS Why is lithium a preferred metal for the making of batteries? About 90% of all limestone rocks form as a result of biologic activity. The Marianas
Trench, Trench Volcanic island arc Oceanic crust Continental crust Lithosphere Lithosphere Ential Asthenosphere Partial melting (b) Mountain range Continental crust Lithosphere Continental crust Lithosphere FIGURE 21.23
Asthenosphere (c) Oceanic crust 569 The three types of convergent margins: (a) oceanic-oceanic, (b) oceanic-continental. Consider the minerals quartz and feldspar. Two lumps of clay with equal and opposite momenta have a head-on collision and come to rest. Reflection, light The return of light rays from a surface in
such a way that the angle at which a given ray is returned is equal to the angle at which it strikes the surface (also called specular reflection). If they have disappeared, or if the jet did not leave a contrail, the humidity of the atmosphere is too low to create clouds and produce rain. Thus, convectional lifting begins again, and another cumulus cloud
begins to form at the same location. Are atoms made of molecules or are molecules or are molecules made of atoms? The upward push of the asthenosphere opposes the downward pull of gravity. Do metals more readily gain or lose electrons? F I G U R E 2 6 .1 3 (a) (b) (a) A model of NASA's Mars Exploration Rover, Spirit, with cameras mounted on the white mast.
The same current exists almost immediately in all three lamps when the switch is closed. If you dangle a weight from the meterstick twist. Water vapor in the early Venusian atmosphere was subject to the Sun's ultraviolet rays, which broke the water down into hydrogen and oxygen. D I S C U S S I O N Q U
ESTIONS (EVALUATION) 109. Minerals are classified by their chemical composition. Beyond the microscopic—the realm of atoms and molecules and an important focus of chemistry. Paul Ryan, former supervisor in the Department of Public Works in Malden, Massachusetts, has for years used molten lead to seal
pipes in certain plumbing operations. One Btu is equal to 1054 \, \mathrm{J}. This property of objects to resist changes in motion is called inertia. For an acidic solution in which Urine 10 - 5 5 the hydronium-ion concentration is Rainwater -4 \, 1.0 \, * \, 10 \, \mathrm{M}, for example, pH = -6 \, \mathrm{Milk} \, 10 \, 6 - \log(1.0 \, * \, 10 - 4) = 4. Pour an equal amount of roomtemperature rubbing alcohol
into the water. Interestingly, the color of paint is a small factor, so either color can be used. The molecules cannot move from their relatively stationary positions, but the water in the pan boils but the water in the pan boils but the water in the pan is put on a hot stove, the water in the pan boils but t
Common Name Melting Point (°C) Boiling Point (°C) Boiling Point (°C) Boiling Point (°C) Methanol Methyl alcohol - 126 97 H OH H C H H H C C OH H H prepared by feeding the sugars of various plants to certain yeasts, which produce ethanol through a biological process known as
fermentation. Just as most of an iceberg is below the water surface (90%), most of a mountain (about 85%) extends into the dense semiliquid mantle. No, no, no—a thousand times no! These objects accelerate equally not because the forces of gravity on them are equal, but because the ratios of their weights to masses are equal. Although he used
evidence from many different scientific disciplines, his well-founded hypothesis was ridiculed by the scientific community. Such pushes by countless molecules produce air pressure. 5 Soaps, Detergents, and Hard Water 16. Potential energy The energy that matter possesses due to its position: Gravitational PE = mgh Power The rate of doing work (or
the rate at which energy is expended): Power = work time Work The product of the force and the distance moved by the force we have the component of the object:
Work = ©KE R E A D I N G C H E C K Q U E S T I O N S (COMPREHENSION) 3.1 Momentum and Impulse 1. When you reduce its (a) volume. When you reduce its (a) volume. When you reduce its (b) volume. When you reduce its (b) volume. When you reduce its (c) volume. When you move, your rainbow appears to move with you.
system formed about 4.5 billion years ago, when dust, gases, and rocky and metallic debris orbiting the newly forming Sun collided and coalesced into the planets, asteroids, and comets we know today. How about my rope? EXPLAIN THIS VIDEO: Boiling is a Cooling Process vaporation occurs at the surface of a liquid. It is the energy given to the
electrons that you should be wary of. To check the action of a fertilizer and then apply the combination to a few plants. The upward component, U, is called lift. It is also the measure of the inertia or sluggishness that an object exhibits in response to any effort
made to start it, stop it, or change its state of motion in any way. 9. Show that an average force of 25 N exerted on a cart for 2 s changes the momentum of the cart by 50 kg # m/s. CHECKPOINT The orbital path of a satellite is shown in the sketch. This makes them excellent polarizers. Describe the motion of the astronauts as the game proceeds.
path would it follow? Chances are about 50-50 that in any night sky there is at least one visible comet that has not been discovered. It is often said that earthquakes don't kill people, but falling buildings do. 1 WEB RESOURCES FOR COSMOLOGY • The Harvard-Smithsonian Center for Astrophysics • The Hubble Space Telescope • The Wilkinson
Microwave Anisotropy Probe The Big Bang Not so long ago it was commonly thought that our Milky Way galaxy comprised the whole universe. Show that the frequency and period of the heartbeats are 1.2 Hz and 0.83 s, respectively. A front is the contact zone between two different air masses. Lateral inhibition exaggerates the difference in
brightness at the edges of places in our visual field. Faraday's law The law of electromagnetic induction, in which the magnetic field changes within those loops. No, the upward force is the normal force, which is the same whether the book is on slippery
ice or sandpaper. Vector quantity A quantity whose description requires both magnitude and direction. The sum of compoVToectors nent vectors is called a resultant. 2 4 This small elliptical galaxy, Leo I, found within the constellation Leo, is only about 2500 light-years in diameter. If there were no gravity the cannonball would follow the straightline
path shown by the dashed line. 7.1 Conduction 2. The life sciences involve fantastic applications of chemistry, nitrogen fixation being just one example. From oldest to youngest, the sequence is G, A, B, C, D, I, H, F. Why is plastic wrap made of polyvinylidene chloride stickier than plastic wrap made of polyvinylidene? Is it possible for one wave to cancel
another wave so that no amplitude remains? She and her hair are charged. In its solid phase, the structure is open spaced. The beam of neutrons, however, is less harmful. The large piston has a diameter of 6 cm. For example, if Earth froze over completely, carbon dioxide released by volcanoes Habitable zone would no longer be absorbed by the
oceans. How does the Doppler effect used in radar guns give the speeds of tennis balls and baseballs at sporting events? Most coal deposits were formed about 300 million years ago, when Swamp 1. As shown in Figure 26.4, sunspots can be seen by focusing the image of the Sun from a telescope or pair of binoculars onto a flat white surface. Shown
that its density is 6000 kg/m3. We have learned how to manipulate these atoms to produce a vast array of new and useful modern materials. But this doesn't mean the water will transfer more thermal energy to an egg than before boiling—an egg in this boiling water won't cook at all! 85. Another commonality is that they all have ring systems,
Saturn's being the most prominent. Because these gouges (glacial striations) still scar many rock surfaces, scientists are able to trace the extent of glaciation. CHECKPOINT What role do neutrons serve in the atomic nucleus? All we need to do is look through our telescopes. The modern periodic table lists the elements in order of increasing atomic
number. Europeans, islanders, and people living near ocean air currents should be glad that water has such a high specific heat capacity. Enormous intergalactic magnetic fields that spread far beyond the galaxies have recently been detected. Debris collects in a ring that accretes into the Moon, which is quite close to the rapidly rotating Earth. In
this way a magnetic field pulls the vehicle forward, while a magnetic field farther back pushes it forward. The Himalayas are the result of continent-continent collision between the Indian Plate and the Eurasian Plate. Enjoy your physical science! To the Instructor T HIS FIF T H EDIT ION of Conceptual Physical Science with its important ancillaries
provides your students an enjoyable and readable introductory coverage of the physical sciences. Electromagnets If a piece of iron is placed in a current-carrying coil of wire, the alignment of magnetic domains in the iron produces a particularly strong magnet known as an electromagnet. In this design, two separate water systems are used so that no
radioactivity reaches the turbine or the outside environment. A second is the occurrence of metamorphic rocks both in the Sierra Nevada and near the trench deposits. The fraction of sound energy reflected from a surface is large if the surface is rigid and smooth, but it is less if the surface is soft and irregular. Hewitt 708: NASA 709: Paul G. The
isotope lithium-7 has a mass of 7.0160 amu, and the isotope lithium-6 has a mass of 6.0151 amu. Cans contain iron. But note that your brain fills in the two intersecting lines. The Andromeda galaxy lies just above the upper leg, directly between the Cassiopeia "W" and the Pegasus box. This movement produces the waning gibbous, last quarter, and
waning crescent phases. Your grandparents are likely interested in your educational progress. Which of Newton's laws is most applicable here? So when the lower string is gradually pulled, the tension supplied by the pull is transmitted to the top string. Three times as far from the rotational axis, there is three times as much tangential speed. Now it
bends farther because it is moving. CHAP TER 27 27.1 Observing the Night Sky EXPLAIN THIS E When can winter constellations be seen in the summer? Discovering this connection between falling water and falling satellites was an "Aha" moment for Paul Hewitt while whirling a water-filled bucket during a rotational-motion classroom
demonstration—on a day when a much-publicized satellite launch was being discussed. Consider a pair of planets for which the distance between them is decreased by a factor of 5. At this time, the Sun, Earth, and the Moon are lined up, with Earth in between. The hydrogen ion, H+, therefore, is simply a proton.) For example, a water molecule, H2O,
can gain a hydrogen ion, H+ (a proton), to form the hydronium ion, H3O+: HOHHW Water WATER
stops. Zero KE means zero speed, so momentum is also zero. If three of these values are known, the fourth can be calculated from this relationship. Hertz The SI unit of frequency; one hertz (symbol Hz) equals one vibration per second. FIGURE 28.8 A two-dimensional analogy of four-dimensional warped spacetime. The lever is then 98% efficient, and
we waste 2 J of work input as heat. If you burn 50 g of wood and produce 10 g of ash, what is the total mass of all the products produced from the burning of this wood? Interestingly, however, gravity plays an even greater part. This raises an interesting question: What other illusions do you have that are not so easily checked? This planetary nebula is
about 3000 light-years away, which places it within our galaxy. The situation is analogous to the flow of water from a higher reservoir to a lower one 195 High voltage at low energy is similar to the harmless hightemperature sparks emitted by a fireworks sparkler. After a car is driven along a road for some distance, why does the air pressure in the
tires increase? If you throw a ball horizontally while standing on a skateboard, you roll backward with a momentum that matches that of the ball. Rocks dropped on the Moon's surface. For a comparison of rigid rock versus less-rigid rock, the 1989 Loma Prieta earthquake in California is a great example. Salt water is a liquid
solution because both the water and the dissolved sodium chloride are found in a single liquid phase. One type is longitudinal (P waves), and the other type is transverse (S waves), and the other type is longitudinal (P waves), and the other type is transverse (S waves). For example, the luminosity of Betelgeuse is 38.000 LSun, (b) If the ball is in the air for 4 s. show that it reaches a height of about 20 m. 2v 2v 1 2 1t = gt 1 t 2 = .2 g Bg d
d v = = t 2y From y = Bg Can you see that solving in terms of symbols better shows that these two problems are one and the same? In water, light travels at 75% of its speed in a vacuum, or 0.75c. Delusional thinking, in general, carries risk. After reaching terminal velocity? Why doesn't a heavy object accelerate more than a light object when both
are freely falling? Likewise, organic molecules can twist and turn about their carbon-carbon single bonds and thus have a range of conformations. The English day names were derived from the language of the Teutonic tribes who lived in the region that is now Germany. C H A P T E R 17 17.4 Catalysts 17. (b) Weather forecasters rely on conceptual
models such as this one to predict the behavior of weather systems. Does sound tend to bend upward or downward when it travels faster near the ground than higher up? From these values, we see that star A has a distance factor of 1, while Star B has a distance factor of 2. Another source of energy is tidal power, by which the surging of tides turns
turbines to produce power. (d) Carbonization occurs when an organism is preserved as a thin film of carbon. How does distillation separate the components of a mixture? (This distinction eludes many people!) O D - N U M B E R E D S O LU T I O N S CHAPTER 6 1. Which has more atoms: a 1-g sample of carbon-12 or a 1-g sample of carbon-13? B
10 N A 15 N 5N 10 N 10 kg 5 kg C 10 N 5 kg 15 N D 5N 20 kg 55. What causes it? To see the different phases that the Moon would have if it were elsewhere in the sky, move your Ping-Pong ball around. Compounds are truly different from the elements from which they are formed. With such a device we would have an amazing window into our past.
The combination of signals cancels the jackhammer noise. (Radar works similarly; microwaves rather than sound waves are transmitted.) LEARNING OBJECTIVE Distinguish between forced vibration and resonance. The Sun, Earth's nearest star, is the solar system's power supply. In water, does the following molecule act as an acid, a base, neither,
or both? (d) force/mass ratio is the same for both. Endothermic Description of a chemical reaction in which there is a net absorption of energy. Iron, for example, is most frequently found as iron oxide, Fe2O3, and copper is found as chalcopyrite, CuFeS2. The differfiner level and so are not readily ent components are visible. The time period is 2025 -
2005 = 20 years. EXPLAIN THIS A FIGURE 4.28 INTERACTIVE FIGURE Fired fast enough, the cannonball goes into orbit. What is the wavelength of the 0.75c light in the piece of plastic? On the Moon there is no atmospheric pressure to push the dust anywhere. This will always be the shortest distance between the axis of rotation and the line along
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which the force acts. Singly charged ions traveling with the same magnetic field will experience the same magnetic force. 276 PARTONEPHYSICS Carbon is ordinarily black FYI in color, but not when chemically bonded with water in foods such as bread and potatoes. (a) yes, if the photon is moving at the speed of light

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(b) yes, if the star's mass-density is huge enough to make it a black hole (c) no, because photons, by definition, always move in straight paths (d) no, because stars already produce countless photons of their own 8. Electrical forces arise from particles in atoms. The first to clearly formulate the concept of acceleration was Galileo, who developed the
concept in his experiments with inclined planes. The alternating pulls and pushes produce a forward thrust. C H A P T E R 15 45. To give two more examples, a calcium atom that loses two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and an oxygen atom that gains two electrons is written Ca2+, and
Middle Ages, such mixtures were described as being C H A P T E R 12 ATO M S A N D T H E P E R I O D I C TA B L E F I G U R E 1 2 .1 2 GROUPS 1 2 3 4 5 6 7 8 9 10 303 11 12 13 14 15 16 17 18 1 H He The size of atoms gradually decreases as we move from left to right across any period. Watch for renewed interest in this form of power that
doesn't pollute the atmosphere. (c) Waves created by vibration at other rates are not self-reinforcing. You see these on instrument panels of many kinds, including VCRs and DVD players. By measuring the rate at which they changed luminosity he estimated their distance, which he found to be much farther away than any star within our own galaxy.
When this occurs, air has been driven out and replaced by steam. Constellations are visible groups of stars in the nighttime sky. Einstein suggested a way to measure this effect when he formulated the principle of equivalence. The rest is re-emitted F I G U R E 11. The most unusual feature of Uranus is its tilt. FIGURE 26.24 The Moon in its various
phases. If the molecules move at the same average speed—or, equivalently, if they have the same temperature—then the number of collisions is doubled. Can you now see more clearly that the temper- kilometer of elevation. The percentage of carbon increases as the hydrocarbon gets bigger: methane's is 20%; ethane, 25%; propane, 27%; butane,
29%. (c) be created or destroyed, but only in nuclear reactions. The effluent is then sent into a tank where any fine particles not removed in primary treatment can settle. An object can reflect only frequencies present in the illuminating light. (d) Radio interference arises adjacent to any radioactive source. This is more dramatic than the larger can of
the preceding activity. Similarly, if an object falls for three times as far. A car moving at twice the speed of another takes four times (22 = 4) as much work to stop. The fresh water can absorb more carbon dioxide because it contains more water (solvent) than the sugar
water. You have probably heard these terms in news reports after an earthquake. What is the advantage of this? As you know, it is quite possible to be familiar with a term without truly understanding the underlying concept. Aluminum is produced primarily by electrolysis. C H A P T E R 16 CHECKPOINT 1. Violet light has the higher frequency. Let's
assume that the rate of seafloor spreading in the Atlantic has been a constant 2.5 cm/yr over geologic time. Assume the total number of molecules in a glass of liquid is about 1,000,000 million trillion. From a distance, Earth and the Moon still resemble a twin planet system, as you can see in Figure 26.23. The current is ac because the induced voltage
is ac. Waves passing through the wire that meet up with themselves, as shown in Figure 12.28b, form a stationary wave pattern called a standing wave (see Section 10.7). Fact: Lightning does favor certain spots, mainly high locations. Accretion of the planets began before the Sun ignited. The atmosphere pushes water from below up into a pipe that
is evacuated of air by the pumping action. Why do your ears pop when riding an elevator? Octane is a component of gasoline. 629: Dirk Wiersma/Photo Researchers, Inc. When the piston is moved downward, the outlet valve opens and the air is pushed out. (c) zoned sequences of minerals. Pierce a nut (pecan or walnut halves work best) with a bent
paper clip that holds the nut above the table surface. If the chain reaction were started in a smaller C H A P T E R 13 T H E ATO M I C N U CL EU S A N D R A D I OAC T I V I T Y 335 Neutron 235 U nucleus Fission fragment FIGURE 13.22 INTERACTIVE FIGURE A chain reaction. Imagine this same mentality applied to corporations whose primary
goal is to increase their profits. Faraday's Law Electromagnetic induction is summarized by Faraday's law: change in a coil is proportional to the number of loops multiplied by the rate at which the magnetic field changes within those loops. 2 Counting Atoms and Molecules by Mass 17. REVIEW 425 73. But
where's the horse?" This story illustrates how difficult it is to abandon our way of thinking about the world when a newer method comes along to replace established ways. This process of collecting a vaporized substance, called distillation, is illustrated in Figure 16.5. Distillation is a very effective, though costly, way of isolating fresh water from
seawater. Then when stress builds to the point where it exceeds the strength of the fault, the rock suddenly snaps—an earthquake! The sudden release of stored elastic energy is very similar to the recoil of a spring. Scientific knowledge helps us predict possibilities in nature even before we experience them. (b) four times as strong. Just after the drop
of solvent is completely absorbed, add a second drop at the same location as the first one, then a third, and so on until the ink components have separated to your satisfaction. Like linear momentum, angular momentum is a vector quantity and has direction as F I G U R E A .1 0 A small object of mass m whirling in a circular path of radius r with a
speed v has angular momentum mvr. Speculations that cannot be tested are regarded as "unscientific." This has the long-run effect of compelling honesty—findings widely publicized among fellow scientists are generally subjected to further testing. For example, the 7 percent growth rate of electric power generating capacity in the United States
means that in the past the capacity had doubled every 10 years [70%/(7%/year) = 10 years]. 226 88 Ra S ?? Why is iron magnetic and wood not magnetic and w
amounts of this organic matter is subjected to low heat over a long enough period of time, chemical changes take place that create oil. Therefore, 1 L of a 1 M solution requires less than 1 L of water. Heat of fusion The amount of energy needed to change a unit mass of any substance from solid to liquid (and vice versa). Because the angles are all the
same, and because each fluorine but in opposite directions, the rope atom pulls on the electrons of its boron-fluorine bond with the oxygen in air to form reddish copper (I) oxide, Cu2O, which is a compound that coats the surface of older pennies, making them look tarnished. In a
warm front, warm air slides upward over a wedge of cooler air near the ground, producing stratus and nimbostratus clouds and drizzly rain showers. 1 Hydrocarbons 19. Because the dry leeward (downslope) sides of mountain ranges are sheltered from rain and moisture, they are often referred to as being in the rain shadow (Figure 25.11).
igneous rocks are formed when molten rock at Earth's surface—lava—cools. Now move the book slowly toward your face, with your right eye fixed on the dot, and you'll reach a position about 20-25 cm from your eye where the X disappears. (b) As the sound leaves the instrument at a speed of 340 m/s, show that its wavelength in air is 1.33 m. It
acquires a slightly concave shape and maneuvers itself by undulating in a graceful S shape, traveling more than 20 m in a single leap. During World War I, Norwegian meteorologists adopted front as a way to describe the boundary line between two "warring" air masses. The chemical energy in fuels is also potential energy. (It is, however, the
weakest oxidizing agent of these three.) Sulfur, S, is in between, and chlorine, Cl, with the greatest electronegativity, is the weakest reducing agent. Large earthquakes have a greater magnitude and release more energy than smaller earthquakes. Hewitt 290: (left) Paul G. This is evident when it propagates through the vacuum between the Sun and
Earth. If each count takes 1 s, counting nonstop to a million would take 11.6 days. 7 The Theory That Explains the Geosphere through Earth, what would we find in its interior? 13.3 Half-Life and Transmutation 8. Corrosion The deterioration of a metal, typically caused by atmospheric oxygen. The greater the force acting on an object, the greater its
change in velocity and, hence, the greater its change in momentum. As was shown in Figure 12.29, seven shells are available to the electrons in an atom, and the electrons fill these shells in order, from innermost to outermost. The action of a piston then compresses these gases into a smaller volume before ignition by the spark of a spark plug. What
is your response? Our Local Group is actually a rather minor component of our Local Supercluster, as is illustrated in Figure 27.36. (b) closer to the Moon's surface. These wraps are made of very long nonpolar molecules with the same molecular
formula but different configurations (and hence different structures) are known as structures) are known as structures is econd. voltage 12 V = = 10 \( \tau \) current = Resistance 60 \( \tau \) At 100,000 \( \tau \), how much current flows through your body
if you touch the terminals of a 12-V battery? This work changes the electric potential energy of the spring (Figure 8.14a). More water vapor in the atmosphere will then enhance the greenhouse effect, causing even warmer temperatures, which will
provide for even more evaporation. The greater the kinetic energy, the greater the impact of molecular collisions—and the greater the air pressure. The karat is the common unit used to describe the purity of a precious metal, such as gold. This energy transfers to the piling below. The greater the air pressure the air pressure.
electrons and thus the more negative is its charge. (a) 0.5 g (b) 0.25 g (c) 0.125 g (d) 0.0625 g 7. Any 4°C water lies at the bottom. FYI The conversion of ozone, O3, to oxygen, O2, is normally sluggish because the reaction has a relatively high activation energy, as shown in Figure 17.14a. What can you deduce about the activation energy of a reaction
that takes billions of years to go to completion? Neither does this second form of matter recognize the electromagnetic force, which makes it invisible to light as well as our sense of touch. The carbon chains of unsaturated fats have double bonds and take on a bent shape, so they don't pack well together. (c) homogeneous mixture because it is all at
the same temperature. Today, we are at the beginning of a similar revolution. With more burial, the increase in heat and pressure caused the peat to lithify to form lignite and bituminous coals. How far will it go in 5 s? A ball is thrown horizontally from a cliff at a speed of 10 m/s. Discuss possible causes of this mass extinction. The skipper sets up a
fan as shown. Rather, the marble is simply following the natural curvature of the rubber sheet. The needle rotates counterclockwise until it aligns with the magnetic field. H3C C H C H Acetone (a) H Propionaldehyde (b) A ketone is a carbonyl-containing organic molecule in which the carbonyl carbon is bonded to two carbon atoms. 3 2 The radiation
curve of sunlight is a graph of brightness versus frequency. Salinity The mass of salts dissolved in 1000 g of seawater. Humidity is the mass of water vapor per volume of air. Two types of weathering Idaho batholith Pacifi c When magma cools beneath Earth's surface, the igneous rock that forms is called plutonic (or intrusive) rock. Fast-moving H2O
molecules rebound upon collision. What two factors contribute to this subdivision? Yes, because it doesn't change its state of motion (accelerate). This makes sense because covalent-bond formation and negative-ion formation are both applications of the same concept: nonmetallic atoms tend to gain electrons until their valence shells are filled. Using
these masses we can measure out equal numbers of atoms or molecules. We'll say the action is your hand (object A) exerting a force on the wall (object B). It is the bumps, depressions, and warpings of geometric spacetime that are the phenomena of gravity. Physics is the study of nature's rules. Because digging such a hole is impossible, what tools
and techniques can we use to explore Earth's insides? xV 120 V 35. So an electron at rest in a stationary magnetic field feels no force to set it in motion. After shaking, there is a pattern in the settling. It is the same except that the roles of electric and magnetic fields are interchanged. Disorder increases and entropy increases. When you walk
toward a mirror you see your image approaching you. Most volcanoes are formed near plate boundaries. Let's turn our attention to the mechanics of gases in particular. A penny and a piece of wood have no magnetic domains that can be induced into alignment. Forced vibration The setting up of vibrations in an object by a vibrating force. When so
plotted, stars' positions take the form of a main sequence for average stars, with exotic stars above or below the main sequence. Members of the American Chemistry Council, who produce 90% of the chemicals manufactured in the United States, have adopted a program called Responsible Care, in which they have pledged to manufacture without
causing environmental damage. FIGURE 2.16FIGURE 2.16FIGURE 2.1 8 In the interaction between the hammer and the stake, each exerts the same amount of force on the other. Would you expect this practice to be more prevalent in winter or summer months? The reason for these receding velocities is the expansion of space itself.
This planetary model is limited, however, in that it fails to explain many properties of atoms. The word plutonic is derived from Pluto, the mythological god of the underworld. Pseudoscience may be promoted to intentionally deceive or it may be the result of flawed and wishful thinking. Why is halite commonly the last mineral to precipitate from
evaporating seawater? Calculate the momentum of a 10-kg bowling ball rolling at 2 m/s. The wavelengths of electron beams are typically shorter than the wavelengths of visible with optical microscopes. CHECKPOINT As long as fuel is available to it, a
given fuel cell can supply electric energy indefinitely. (c) is appreciably reduced. The speed of the source are the same when a wave barrier is produced. Away from Earth's surface where the force of gravity is less. (on the Moon, for example), the bag would weigh less. We'll investigate the relationship between distance
traveled and the square of the time for constant acceleration more closely in the case of free fall. As the tools of science improve, then assessment of the most probable gets closer to being on target. See also Phase changes Physical properties, 352 Physical sciences, 9-10 Physics, 9-10 Physics
747-748 Planets, 709, 714-721. Was it at some now far distant point from which we have long since traveled? The story tells us that Archimedes came to the solution when he noted the rise in water level while immersing his body in the public baths of Syracuse. The leading source of naturally occurring radiation is radon-222, an inert gas arising from
uranium deposits. C H A P T E R 12 1 2 1 H He 2 Li Be 3 PERIODS 11 4 12 3 Na Mg 19 4 K 20 25 27 29 5 6 7 8 9 10 B C N O F Ne 18 13 14 15 16 17 Al Si P S Cl Ar 31 32 33 34 35 22 23 24 Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 41 42 21 26 28 30 36 38 39 40 52 53 54 5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe 56 57 72 85
86 37 55 73 74 43 75 44 76 6 Cs Ba La Hf Ta W Re Os 87 7 88 89 104 105 106 107 108 45 46 47 48 49 51 50 77 78 Ir Pt Au Hg Tl Pb Bi Po At Rn 109 110 79 111 80 112 81 113 83 82 114 115 84 116 117 118 Fr Ra Ac Rf Db Sg Bh Hs Mt Ds Rg Cn Uut Uuq Uup Uuh Uus Uuo 58 Inner transition metals 59 60 61 62 63 64 65 66 67 68 69 70 ATO M S A N
D T H E P E R I O D I C TA B L E 305 F I G U R E 1 2 .1 6 The typical display of the inner transition metals. If no medium exists to vibrate, then no sound Wavelength is possible. To understand how an oxidation-reduction reaction can generate an electric current, consider what happens when a reducing agent is placed in direct contact with an
oxidizing agent: electrons flow from the reducing agent to the oxidizing agent to the oxidizing agent. What is a mirage? FYI 13.1 Radioactivity? We can see the different structural features of pentane, and neopentane more clearly by drawing the molecules in two dimensions, as
shown in the middle row of Figure 19.1. Alternatively, we can represent them by the HFIGURE 19.1 These three hydrocarbons all have the same molecular formula. Waves of the same frequency can interfere destructively or constructively or constructively or constructively.
waves must have different frequencies. It transfers heat to a second lower-pressure water system, which operates the turbine and electric generator in a conventional fashion. Early on, updrafts are stronger than the downward motion of the droplets, and all droplets are repeatedly blown upward—rain does not fall. Sulfur dioxide is readily converted
to sulfur trioxide, which reacts with water to form sulfuric acid: 2 SO2(g) + O2(g) h SO3(g) Sulfur trioxide SO3(g) + H2O(/) h H2SO4(aq) Sulfur trioxide SO3(g) + H2O(/) h H2SO4(aq) Sulfur trioxide SO3(g) + O2(g) h SO3(g) + H2O(/) h H2SO4(aq) Sulfur trioxide SO3(g) + H2O(/) h H2SO4(aq) 
of-chapter questions are available to instructor Resource Center and in the Instructor Resource Center and Instructor Resource Cen
increase, decrease, or remain unchanged? Suppose you get a prospective employer to agree to hire your services for wages of a single penny for the agreement for a month. Lithosphere The entire crust plus the rigid portion of the mantle that
is above the asthenosphere. Cells can repair most kinds of molecular damage caused by radiation if the radiation is not too severe. For Earth science feedback we remain thankful to Mary Brown, Ann Bykerk-Kauffman, Oswaldo Garcia, Newell Garfield, Karen Grove, Trayle Kulshan, Jan Null, Katryn Weiss, Lisa White, and Mike Young. This is just like
when you're sitting in a train that begins moving eastward. According to this definition, you are as heavy as you feel; in an elevator that accelerates downward, the supporting force of the floor is less and you weigh less. The flow of water in the pipe, like the flow of charge in a wire, ceases when the pressures at each end are equal. Will light pass
through a pair of Polaroid filters when their air axes are aligned? Show that the pressure on your finger is 20 N/cm2, or is 200 kPa. 52. You know that two small pieces of Velcro are easier to pull apart than two long pieces. Complete the sketches and show some positions of the wheels inside each plot and on the other side of each plot, thereby
indicating the direction of travel. (c) more than 35 m/s. Do it loudly and in a single breath. A wiggle in space and time is a wave. The combination of silicon and oxygen is called simply silica (SiO2). As we will soon see, the constant flowing movements in the asthenosphere greatly affect the surface features of our planet. Notice also that many bridges
have tongue-andgroove gaps called expansion joints (Figure 6.16). This poses a problem for surface vessels that bounce ultrasonic waves off the bottom of the ocean to chart its features, but it's a blessing to submarines that wish to escape detection. The Doppler effect also occurs for light. But they are not able to penetrate deeply into denser
materials such as aluminum. Calculate the power of a hair dryer that operates on 120 V and draws a current of 10 A. This curve helps explain why hot summer days can feel very muggy. Examples of this kind of volcanic activity occurred at Mt. Vesuvius in AD 79, at Mt. Pelee in 1902, and at Mt. St. Helens in 1980. Consider the balanced seesaw in
Figure A.7. Suppose the girl on the left suddenly gains 50 N, such as by being handed a bag of apples. In some homes, the water is so hard that it must be passed through a watersoftening unit. An interaction requires a pair of forces acting on two objects. Yes, as is everyone else's and everything around you. The Doppler effect is about changes in
frequency, not speed. The gravitational force is 9.8 N. FYI crown, but determining its volume was a problem. Find and circle the two isoprene units in each of these molecules. This is because the pushes occur at the right time and repeatedly occur in the same direction as the instantaneous motion of the fork. How much buoyant force acts on it?
Activities that tell you more about yourself are valuable ones. State and federal governments can also play a role in educating the general public and in setting packaging standards for companies that use recyclable materials to package their goods. As a galaxy recedes, the wavelength of light reaching us is stretched out. Only one end of the lamp
filament is connected to the cell in circuit 4.) 111. Mohs scale of hardness A ranking of a mineral's hardness, which is its resistance to scratching, thunder, and hail. Or absorbed energy may increase the amount of internal vibration or
rotation within the molecules, which adds to the stored energy but does not raise the temperature. 5 Black Holes 27. Longitudinal wave A wave in which the medium vibrates in a direction parallel (longitudinal) to the direction in which the wave travels. Instead, they combine with protons to form neutrons. 10 Musical Sounds about us wiggle and
jiggle— the surface of a bell, a string on a violin, the reed in a clarinet, lips on the mouthpiece of a trumpet, and the vocal cords of your larynx when you speak or sing. At this time, we see half the sunlit part of the Moon (position 3 in Figure 26.25). An atom's mass number requires no units because it is simply a count. Which of the boxes above best
represents a solution? A more familiar type of diode is the light-emitting diode (LED). Also, PET fibers are sold as Dacron polyester, a product used in clothing and stuffing for pillows and sleeping bags. 158 PA R T O N E P H Y S I CS CHECKPOINT 1. The more branches in both cases, the less the overall resistance. This is a step-up transformer. The
methods of stoichiometry are developed much further in general chemistry courses. What is the net force on the object in this case? scopic hairs called spatulae, each of which is about 300 The force of attraction. I can't do it either." Perhaps we are not too different
from the great thinkers around Galileo who couldn't think of a moving Earth! CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E Einstein made a third prediction—that gravity causes a slowing down of time. And the lithospheric plates move because they are the upper part of the mantle convection cells. After slightly tightening the
string, he hears five beats per second. Quartzite (Figure 20.36b) is metamorphosed quartz sandstone, and it is therefore very hard (hardness 7). Sn2 + 2 Ag h Sn + 2 Ag + (a) The tin ion, Sn2 + , is oxidized, while the silver, Ag, is reduced. What acid are you adding? The clouds are nimbostratus. If the difference in height between the crest and
trough of a wave is 60 cm, what is the amplitude of the wave? Calculations of the total mass of the universe showed that the universe itself should be curved in very detectable ways. These materials and the thousands of others produced by humancontrolled chemical reactions have dramatically improved our living conditions. 8 Thermal Expansion 6.
A thick metal wire is shown here, but the path from one terminal to the other is usually an electric circuit. In other words, they usually do not form chemical bonds with other atoms. How can a single Polaroid filter be used to show that the sky is partially polarized? the can from the stove and screw the cap on tightly. When the magician says
"abracadabra" (and pushes a switch that starts current flowing through the coil under the table), the ring jumps into the air. Then, with little or no net evaporation to cool you, you feel uncomfortably warm. The molecular nature of a diamond is responsible for its extreme hardness. FYI 3 Tl Pb Bi Po Uut Uuq Uup Uuh Uus The elements of groups 3
through 12 are all metals that do not form alkaline solutions with water. Glacial striations found on land can be used to tell the direction of ice movement. Deviations to this can arise because of Earth's 23° tilt and because the Moon's orbit lies 5° outside the ecliptic. F I G U R E 11 .1 6 A magnified view of the surface of ordinary paper. Compared to
the kinetic energy of the slower airplane, the kinetic energy of the faster airplane is (a) the same. That's because we are accustomed to measuring matter by gravitational attraction to Earth. Explain how this happens. We can get a glimpse of this curvature by considering a simplified analogy in two dimensions: a heavy ball resting in the middle of a
large rubber sheet. Sodium cyanide, NaCN, is a deadly poison. We see from Figure 13.32 that, as we move along the list of C H A P T E R 13 T H E ATO M I C N U CL EU S A N D R A D I OAC T I V I T Y elements from hydrogen to iron, the average mass per nucleon decreases. 9.4 FIGURE 9.9 Electric Currents and Magnetic Fields EXPLAIN THIS
What increases when a current-carrying wire is bent into a loop? Many early astronomers believed the universe consisted of a finite number of stars enclosed within some sort of huge black wall. CHECKPOINT To what does the environmental lapse rate refer? 2 Electric field INTERACTIVE FIGURE The electric and magnetic fields of an
electromagnetic wave in free space are perpendicular to each other and to the direction of motion of the wave. Precipitate A solute that has come out of solution. Does it matter that they are there? FYI CHECKPOINT What do all monomers that are used to make addition polymers have in common? Centuries from now, what attitudes about the
green shirt appears magenta—the complementary colors. When nuclear fusion occurs fast enough, thermal pressure becomes strong enough to halt the gravitational contraction. So more water vapor in the atmosphere caused even more warming, which caused more of the oceans to evaporate, causing further warming—runaway global warming!
 Venus's early oceans contained massive amounts of dissolved carbonates, just as on Earth. (Don't do this with a can you expect to use again.) 41. The natural frequency of vibration for electrons in glass is the same as the frequency of ultraviolet light, so resonance in glass occurs when ultraviolet waves shine on glass. This is illustrated in the pair of
shaded rectangles to the right. How might you lead him to accept the concept of molecules? But they were confused about motion. Why does one electrode put out twice as much gas as the other? 696 PARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEARTHREEEARTHREEARTHREEEARTHREEEARTHREEARTHREEEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHRE
force of 120 N is required to push a bookcase across a floor at a constant velocity. At lower wave frequencies, such as those of visible light, electrons in the glass are forced into vibration at a lower amplitude. This possibility has since been eliminated. The term lava refers both to the molten rock itself and to the solid rock that forms from it. (d) CFC
formation of carbon dioxide is balanced because each side shows one carbon atom and two oxygen atoms. FYI Were these your answers? 12.2 The Elements 4. Schists usually contain about 50% platy minerals—most commonly muscovite and biotite. What happens to the direction of the magnetic field about an electric current when the direction of the
current is reversed? Named for the movement they accommodate, the three types of plate boundaries are (a) divergent, (b) convergent, and (c) transform boundaries. When an electric field is imposed on them, they align with the field as a compass needle aligns with a magnetic field. Now suppose instead that the can is a flexible container that can
expand. Scientific thought was furthered in the 16th century with the advent of the printing press. Primary wastewater treatment removes the bulk of solid waste and sludge from the same direction. Under normal conditions, hydrogen behaves like a
nonmetallic gas. Utility companies use circuit breakers to protect their lines all the F I G U R E 8. Does the buoyant force on it change? As the weight of overlying sediments presses down on deeper layers, sediment particles are squeezed and compacted together. The resulting atom is an element two spaces back in the periodic table of the elements
What creatures might survive? From these two simple examples, it is easy to see the importance of minerals in the geosphere and in our lives. The process is the ignition of nuclear fuel and subsequent thermonuclear fusion. The current does not "pile up" or accumulate in any lamp but flows through each lamp. A piece of iron strengthens the
usually Earth's surface. This is a chemical change, because new materials (the two gases) are formed as the atoms originally found in the water molecules are rearranged. Why doesn't the pressure of the atmosphere break windows? 2 0 Light rays deflected by the gravitational field around a black hole. (Do not use insulating Styrofoam cups.) Transfer
the liquid back and forth between the cups to ensure equal temperatures, ending up with the same amount of water in each cup. Partial melting is the incomplete melting of rock. charge energy energy * = time charge time ** It turns out that the power formula P = IV doesn't apply to CFLs because the alternating voltage and current are out of step
with each other (out of phase), and the product of current and voltage is larger than the actual power consumption. What process changes a protostar into a full-fledged star? The force vectors act in a direction perpendicular to the inner container surface and increase with increasing depth. It is a dry, cold flow that maintains the supply of cold air
behind the cold front. With respect to the station, the astronauts experience zero g. 6 Purifying the Water we Drink 16. How does the specific heat capacities of other common materials? The gas has more surface area in the disk shape, which allows it to radiate more energy. The tree gains weight. A
ball's minimum speed occurs at the top of its trajectory. This pigment is red at low pH values, light purple at slightly acidic pH values, light green at moderately alkaline pH values, light purple at slightly acidic pH values, light green at moderately alkaline pH values, and dark green at very alkaline pH values, light purple at slightly acidic pH values, light purple at slight purple at slight purple at sl
262 Hz and also a blending of partial tones of two, three, four, five, and so on times the frequency of middle C. All three astronauts have the same mass and are equally strong. Bernoulli's principle The pressure in a fluid moving steadily without friction or external energy input decreases when the fluid velocity increases. These changes include times
when the magnetic north and south poles were reversed. Name 10 elements you have access to macroscopic samples of, 327 full, 724 phases of, 723-724 solar eclipse and, 727-728
spin of, 725 Motion, 14-31 acceleration and, 27-30 Aristotle's concept of, 15 dynamic equilibrium rule and, 23 of Earth, 40 equilibrium rule and, 21 force of friction and, 28-30 Galileo's concept of, 16-17 inertia and, 16-18 net force and, 19 Newton's laws of, 38-60. C H A P T E R 10 REVIEW 257 F O U R I E R A N A LY S I S In 1822,
the French mathematician and physicist Joseph Fourier made a discovery with application to music. Show that there is no change in the force of gravity between two objects when their masses are doubled and the distance between them is also doubled. What sports events don't make use of Newton's laws? How much friction acts on it? This explains
why the same side of the Moon always faces Earth (Figure 26.27). Sunlight evaporates water molecule, what is the temperature of the box on the left? Light from a distant galaxy is the light
from glowing elements, which emit spectra of particular frequencies as discussed in Section 12.6. An examination of the spectrum of a galaxy's light shows a pattern of peaks that are the sum of the spectra of all of the many glowing elements, primarily hydrogen and helium. The second outer planet, Saturn, famous for its extensive ring system,
would be the size of a baseball more than a kilometer away. The full galaxy, visible only with more powerful telescopes (and time exposure), is about six times the diameter of the Moon! T H I N K A N D S O L V E ( M AT H E M AT I C A L A P P L I C AT I O N ) 34. If distances are short, the surface waters move in the same direction as the wind. In the
absence of an unbalanced external torque, the angular momentum of that system is constant. The residue that remains will be the salt. When we breathe, we inhale oxygen, O2, and exhale carbon dioxide, CO2, plus water vapor, H2O. The flavor of chocolate is generated when a selection of compounds, such as tetramethylpyrazine, are absorbed in the
nose. Discuss the reason for this. The bulb is designed for use in a 120-V circuit. Electric Circuits EXPLAIN THIS How can a circuit be connected so that the current in each part is the same? CHECKPOINT The melting of gold is a physical change. (b) mass of what's being hit. We pay attention to the boundary and ignore the rest. LEARNING
OBJECTIVE Show how the mass of a nucleon depends on the identity of the nucleus within which it is contained. But out of this very large number, it may surprise you to learn that just eight elements make up 98% of Earth's entire mass (Figure 20.2)! All of the other elements combined make up the remaining 2%. (The two sides of the valley move
away from each other because they are located above mantle convection cells that have the same circulation pattern as the cells in Figure 21.18.) (c) Water from the ocean drains in as the rift drops below sea level, forming a linear sea, so called because it is usually long and narrow. Elements that tend to form covalent bonds are primarily nonmetallic
elements. The water content of the rock also changes with distance from the contact. (c) There is a gradual change: the farther apart, the more ionic. Earth rotates much faster than Venus. How would Galileo interpret it? Your body tends to remain at S-2 O D D - N U M B E R E D S O LU T I O N S rest, in accord with Newton's first law. Some current
travels in each path. Kepler discovered that planetary paths are elliptical, but never knew why. This would be 546 K, or 273°C. Sharpen both ends of two pencils. This question should elicit much discussion! 106. 1 Temperature (C) 0 10 20 25 30 35 40 Air is a gaseous solution, and one of its minor components is water vapor. 5 m? When walking in
space, why do astronauts keep to altitudes beneath the Van Allen radiation belts? What scenario for the fate of the universe proposes that cosmic inflation is not a one-time event? (a) infrared (b) visible (c) ultraviolet (d) gamma rays 6. A change in the skater's distribution of mass changes the spin rate. Why is saying you have 1 mole of water
McIntyre/ Photo Researchers, Inc. Which has the higher pitch: the short-wavelength sound or the long-wavelength sound or the long-wavelength sound? Here on Earth gravity keeps space nice and tight. Some common names are water for H2O, ammonia for NH3, and methane for CH4. PROLOGUE T H E N AT U R E O F S CI E N CE RISK ASSESSMENT The numerous benefits of
technology are paired with risks. LEARNING OBJECTIVE Relate current, voltage, and resistance in electric circuits. You are made of stardust, as is everything that surrounds you. Rank the minerals in their order of crystallization: (a) quartz, (b) feldspar, (c) olivine, (d) pyroxene. No one fully realized the dangers of combustion products when
petroleum was selected as the fuel of choice for automobiles early in the last century. In everyday usage, we consider minerals provide the raw materials needed for industry (aluminum for cans, iron for steel, etc.). The result is a covalent crystal, which, as shown in Figure 15.20, is a highly
ordered, three-dimensional network of covalently bonded atoms. Why aren't you moved upward by this force? This, however, leads to the picture on television screens reveals that the picture is an assemblage of tiny spots, each less than a millimeter across. About
how old is the ax handle? For example, when an electron moves by you, a definite magnetic field is associated with the moving electron. where d is the distance between the charge of the second particle, and k is the proportionality constant. If you are
at the source, the echo sounds as if it originated on the other side of the wall from which it reflects (just as your image in a mirror appears to come from behind the glass). Because many of these compounds are fragrant, any organic molecule that contains a benzene ring is classified as an aromatic compound (even if it Saturated hydrocarbon FIGURE
19.7 The carbons of the hydrocarbon butane are saturated, each being bonded to four other atoms. Without a magnetosphere, the bulk of the early Martian atmosphere—no longer replaced by volcanoes—was carried away into space by solar winds. The final temperature of the water will be the same as that of the ice, 0°C. The Andromeda galaxy, for
example, is the 31st entry of this catalog and is thus listed as M31. Now, when I look at any motionless object, I know immediately that all the forces acting on it cancel out. Combustion is an oxidation-reduction reaction between a nonmetallic material and molecular oxygen. Remember—our Earth is very old, and there have been many changes to its
surface. (d) all of these (e) none of these 4. (a) Neglecting inefficiencies, how does the PE of Art at the top of his trajectory compare with the PE of Bart jumps? (Vectors are treated in Appendix B and are nicely developed in the Conceptual Physical Science Practice Book.) Constant speed means steady speed, neither speeding up nor
slowing down. Radiation Curves of Stars As you learned in Chapters 7 and 11, all objects with a temperature emit energy in the form of electromagnetic radiation. This checks: 300 N * 2.5 m = 500 N * 1.5 m. Crack open an egg and place the egg white and the yolk into two separate bowls. (a) long molecular strands because they tend to tangle among
themselves (b) short molecular strands because of a greater molecular strands because of a greater molecular strands because their ends are typically polar Answers to RAT 1. While on the subject of the second law of thermodynamics, we would be remiss not to think about the close relationship between
entropy and our psychological sense of time. When tap water is left boiling on the stove too long, it evaporates completely but leaves a chalky residue in the pot. 13 60 35 75 25 75 * Meteors appear to radiate from a certain region of the sky, appropriately called a radiant. The Great Rift Valley of East Africa is an excellent example of such a feature; if
the spreading continues, it may be the beginning of a new ocean basin. This is the principle that underlies a mechanical vacuum pump. Each streak is a tiny chip of a comet, once so very far away, that has fallen into Earth's neighborhood (Figure 26.46). What is the most abundant element in Earth's crust? In a circuit with two lamps in parallel, if the
current in one lamp is 2 A, the current in the battery is (a) half, 1 A. Gemstones are solid solutions. Some three months before the end, solar systems will disperse. Pure Element Gold, Au Sulfur, S8 Nitrogen, N2 Orange juice may be 100% natural, but it is never 100% pure. See also Acid-base reactions strength of, 459-462 Basic solutions, 462-465
oceans as, 469-470 pH of, 465-466 Batteries, 473-476 alkaline, 474-475 disposable, 473-476 dry-cell, 473-475 dry-cell, 475 leta particles, 323 Big Bang, 755, 769-777 cosmic background radiation and, 772-773 cosmic inflation and, 775-775 dry-cell, 473-475 dry-cell,
777 dark matter and, 781-782 galaxy formation and, 782-783 hydrogen and helium abundance and, 774 Big Rip, 786 Black holes, 750-754 Blazars, 759 Body waves, 556-557 Boiling, 176-178 Boiling, 176-178 Boiling point, 385 Bond(s), 367-385 covalent, 376-385 electron-dot structures and, 368-369 hydrogen, 386-387 ion formation and, 369-372 ionic, 372-375
metallic, 375-376 molecular polarity and, 382-385 nonpolar, 380 polar covalent, 379-382 Bond energy, 442 Bottled water, 417-418 Bow waves, 253 Boyle's law, 127-128 Bracelets, ionized, 190 Breeder reactors, 337-338 Buoyanty, 123-126 in gas, 133-134 Buoyant force, 123 C Cambrian period, 630-631 Carbon-140 Bow waves, 253 Boyle's law, 127-128 Bracelets, ionized, 190 Breeder reactors, 337-338 Buoyanty, 123-126 in gas, 133-134 Buoyant force, 123 C Cambrian period, 630-631 Carbon-140 Bow waves, 253 Boyle's law, 127-128 Bracelets, ionized, 190 Breeder reactors, 337-338 Buoyanty, 123-126 in gas, 133-134 Buoyant force, 123 C Cambrian period, 630-631 Carbon-140 Bow waves, 253 Boyle's law, 127-128 Bracelets, ionized, 190 Breeder reactors, 337-338 Buoyanty, 123-126 in gas, 133-134 Buoyant force, 123 C Cambrian period, 630-631 Carbon-140 Bow waves, 253 Boyle's law, 127-128 Bracelets, ionized, 190 Breeder reactors, 190 Breede
dating, 332-333 Carbonate dissolution, 598-599 Carboniferous period, 633 Carbonyl groups, 502-506 Carboxylic acid, 504 Cars. So the direction of the rolling wheels is bent toward the "normal," the black dashed line perpendicular to the grass-sidewalk border in Figure 11.17. 631: Shutterstock 632: Tom McHugh/Photo Researchers, Inc. Is
radioactivity on the Earth something relatively new? The supergiants are even larger and brighter than the giants. The planet and its moon gravitationally attract each other. C.. The gas that forms, with its added energy, condenses to a liquid in outside coils in the back—appropriately called condensation coils. (a) Equal and opposite charges. With the
m) = = 0.5 s g B B 10 m/s2 (b) The horizontal speed of the ball as it leaves the table, using time 0.5 s, is vx = vx = SAM PLE PROBLEM 2 (a) To remain within the court's border, a horizontal distance d from the bottom of the net, ignoring air resistance and any spin effects of the ball, show that the ball's maximum speed over the net is v = d 2y Bg (b)
Suppose the height of the net is 1.00 m, and the court's border is 12.0 m from the bottom of the net. What happens to the submerged open bottom until the difference in the mercury levels in the tube and the dish is 76 cm. According to nebular theory, what
happens to a nebula as it contracts under the force of gravity? The hydrosphere includes Earth's fresh water—rivers, glaciers, and groundwater—and Earth's saline water—the oceans. Why is such a solution impossible to prepare? In 1632 Galileo published his first mathematical treatment of motion—12 years after the Pilgrims landed at Plymouth
Rock. Does a car burn more fuel when its lights are turned on? Neither. The solution is supplied with ions as chromium atoms in the cathode are oxidized to Cr2 + ions. How can soot emission be reduced? The vertical distance beneath the dashed line at the end of 5 s is 125 m [looking at magnitudes only: d = 5t 2 = 5(5)2 = 5(25) = 125 m]. If the
sound of an airplane does not originate in the part of the sky where the plane is seen, does this imply that the airplane is traveling faster than out of water? Gravitation near the surfaces of these shrunken stars is so enormous that
light cannot escape from them. The circulatory motion produces convectional lifting. As the element gains the oxygen, it is losing electrons to that oxygen because of the oxyge
the mass marks the relative displacement on the slowly rotating drum beneath. Small amounts of heat added to 0°C ice or to 100°C water, for example, don't increase the temperature. (b) At 25°C, the atoms in a sample of mercury are a certain distance apart, yielding a density of 13.53 g/mL. Is a black hole's event horizon a physical or mathematical
boundary? A mirage is a distorted view in which refracted light appears as if it is reflected light. TUTORIAL: Plate Boundaries and Plate Tectonics 568 PARTHSCIENCE = 1.92 * 108 yr 2 190 million years Calculating the Age of the Atlantic Ocean If you can estimate the rate of seafloor
spreading and you know the present width of an ocean, you can calculate the ocean basin's age. In a conglomerate rock, why are pebbles of granite very common and pebbles of granite very common? FYI 572 PART THREEAR THREEAR
Lithosphere Asthenosphere FIGURE 21.26 The continental collision of India with Asia produced—and is still producing—the Himalayas. Devastating earthquakes can occur with all three types of faults: reverse, normal, or strike-slip. Instead we have the nucleus of a different element—thorium. There is a difference between force and
homeless. (d) Oppositely charged cylinder and plate. As water warms, the hydronium-ion concentration increases, albeit only slightly. For example, the kinds of minerals found in volcanic rocks provide evidence that molten rock erupted from Earth's interior to the surface. This duality is an extension of Einstein's famous equation E = mc 2, which tells
us that matter and energy are interconvertible. This has the effect of distorting the atom or molecule (Figure 8.7). Hewitt 268: Paul G. Heating the glass, however, takes longer. Since the acceleration is uniform, the average in any time interval is found the same way we usually find the average of any two numbers: add them and divide by 2. But as she
gets closer to the black hole, only light directed nearer to the vertical gets out, until finally even verti
perceived as a continuous tone. 1 million coins? the same temperature. Most nations now recognize this as a dangerous attitude. Acceleration The rate at which velocity may be in magnitude or direction or both, usually measured in m/s2. Aromatic compound Any organic molecule containing a benzene ring.
At .. An alloy is a mixture composed of two or more metallic elements. An air mass formed over water in the tropics is different from one formed over land in the polar regions. A boulder (its weight) is 100 times the force (or weight)
on the pebble, its resistance to a change in motion (mass) is 100 times that of the pebble. Why will more voltage be induced with the apparatus shown in the preceding exercise if an iron core is inserted in the coils? Rank the buoyant force supplied by the atmosphere on the following, from greatest to least: (a) an elephant, (b) a helium-filled party
balloon, and (c) a skydiver at terminal velocity. As illustrated in Figure 12.18, the diameter of an object visible under the highest magnification must be larger than the wavelengths of visible light. Thus, our view of the Andromeda is likely more spectacular than the Andromeda is likely more spectacular than the wavelengths of visible light.
than low-density polyethylene? x1 00 F I G U R E 2 6 .1 8 Saturn is one of the most remarkable objects in the sky, with its rings clearly visible through a small telescope. Try it in all directions. Other intriguing applications of thermal physics make up this chapter. How is the melt different from the original rock? Each badge consists of a small piece of
photographic film enclosed in a lightproof wrapper. 12.8 Electron Waves EXPLAIN THIS I How is a plucked guitar string like an electron in an atom? (a) more than 50 g (b) 10 g (c) less than 10 g (d) 50 g (e) none of the above 9. The vapors inside the cool tube condense and collect in the flask on the right. Before the firing, the system is at rest and the
momentum is zero. FYI Only a few metals—gold and platinum are two examples—appear in nature in metallic form. Because of this, many people mistakenly think that a watt is a unit of brightness; but it isn't. Because of this, many people mistakenly think that a watt is a unit of brightness; but it isn't. Because of this, many people mistakenly think that a watt is a unit of brightness; but it isn't. Because of the relatively short half-life of carbon-14, only trace amounts would be left after 50,000 years—too little to be statistically accurate
©T = 0.5mgh/cm = 0.5mgh/cm = 0.5gh/c = (0.5) (9.8 N/kg)(100 m)/450 J/kg = 1.1°C. The net amount of energy released by the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in potential energies of the reaction is equal to the difference in 
and use the minerals dissolved in the water to make their shells, skeletons, and cell walls. From P = R = 10.9 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 + 10.0 +
1 mole of N2 with 1 mole of O2 yields 2 moles of NO. (You will notice a similar effect when you remove a nail from a piece of wood. (b) heat is subtracted by evaporation. Half-frozen fruit punch is always sweeter than the same fruit punch completely melted because (a) the sugar sinks to the bottom. What does it mean to say that momentum (or any
guantity) is conserved? A hydrogen fuel cell, for example, produces clean water suitable for drinking. Melting occurs because pressure is reduced on this rock as it nears the surface. Convection ovens are simply ovens with a fan inside. The flow of charge persists until both ends reach the same potential. The dashed line surrounding the orange persists until both ends reach the same potential.
encloses and defines the system. Because a blue-hot star has twice the light frequency of a red-hot star, it has twice the surface temperature (by earthly standards), it emits radiant energy at a high frequency—much of it in the visible portion of the * The radiation we are
talking about here is electromagnetic radiation, including visible light. That means that a vertically accelerating electron emits light that is vertically polarized. For example, 2 H2O indicates two water molecules, which contain a total of four hydrogen atoms. Why does smoke from a campfire look bluish against trees near the
ground but yellowish against the sky? The greatest mass per nucleon occurs for the proton alone, hydrogen, because it has no binding energy to pull its mass down. Their sensation of weight feels as real as that due to gravity. Extreme heat on a July day caused the buckling of these railroad tracks. If we know two of the quantities in Newton's second
law, we can calculate the third. The question arose as to whether electricity could be produced from magnetism. Space is in the universe. In the sequence of crystallization, olivine crystallizes first, pyroxene second. Assuming the speed of sound in air is about 340 m/s, in 3 s sound travels 340 m/s * 3 s = 1020 m. Later stars incorporated these heavier
elements in their formation. 786 PART FOUR ASTRONOMY FIGURE 28.22 Big Rip Constant, we can expect our universe to suffer heat death. Second, draw another dashed line through the tail end of the vector at right angles to
 the first dashed line, 85. This is because the induced voltage produces a current, which makes an electromagnet, which repels the magnet in our hand. When he pulls the weights inward, the distance is considerably reduced. Consider a neutral solution that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration of [H3O+] pH 1.0 * 10-7 M. Pump Second hole Hydraulican that has a hydronium-ion concentration that has a
fracturing 81 FIGURE 3.35 The power harvested by photovoltaic cells can be used to extract hydrogen for fuel-cell transportation. The pressure in the piston chamber is reduced to one-third. Foliation does not develop if the rock does not develop if the rock does not develop if the rock does not have the right chamber is reduced to one-third. Foliation does not develop if the rock does not develop if the rock does not have the right chamber is reduced to one-third.
in 0.5 s. The ridge stretches 19,312 km, and its highest peaks emerge above sea level to form oceanic islands, such as Iceland and the Azores (Figure 21.17). Seismic waves radiate out from the focus in all directions. We refer to this collection of far-out objects as the Oort cloud (Oort rhymes with court). Can an object be in mechanical equilibrium
when only a single force acts on it? As the magma rises and/or is impeded by overlying lithosphere, crystallization occurs. The reaction of large amounts of hydrogen and oxygen, for example, provides the energy to lift the space shuttle shown in Figure 17.19 into orbit. The larger piston can lift 9 times the input force applied to the smaller piston. FYI
Measurements of the ocean floor began during World Wars I and II as echo-sounding devices—primitive sonar systems— began to measure ocean floor and return. You'll notice that answers to the questions can be found within the
chapters. Use the same formula to show that 1257 J is required to raise the temperature of the same mass (0.030 kg) of water through the same for any given depth below the surface, regardless of the shape of the containing vessel. An immediate buildup of
charge in either the zinc or the copper prevents continued oxidation-reduction from occurring. Adding carbon dioxide readily transforms into carbonic acid. (d) it emits alpha and beta particles moving through supersaturated vapor leave trails. Since each scale reads 350 N,
Lucy's total weight is 700 N. Will you roll backward if you hold onto the ball while going through the motions of throwing it? If the retarding effect of friction can be ignored, no horizontal force acts on the ball and its velocity is constant. (a) v = t t t 14 s 55. When heat is added to an air mass, its temperature, its pressure, or both increase. When you
find yourself carried away by a thought, label the thought as "thinking" and let the thought drift away. It is reflected instead. An ore is a mineral deposit rich in valuable metals that can be extracted for a profit. 2 8 The bunny's dark fur absorbs all the radiant energy in incident sunlight and therefore appears black. Ordinary magnets have longer
ranges. In the fifth century, for example, the Indian astronomer Aryabhata taught that Earth circles the Sun, not the other way around (as the rest of the world believed). (b) Rift valley forms as crust is pulled apart. Recall that sound waves stretch out when the sound source approaches. What is the
approximate mass of a carbon atom in atomic mass units? When upper regions of the atmosphere are warmer than lower regions, we have (a) convective lifting. Coal, oil, and gas are all fossils, in the sense that they are the remains of past organisms. Flatten some aluminum foil on the bottom of a cooking pot. Dissolved materials in water, especially
small quantities of salt, lower the resistance even more. Just because a material is not soluble in one solvent, however, does not mean it won't dissolve in another. At what temperature do the combined effects of contraction and expansion produce the smallest volume of water? FIGURE 18.11 The pH values of some common solutions. If any dark
matter did come to Earth, it would fall right through the surface and probably accumulate in Earth's core. 472 PA R T T W O CH E M I S T RY Oxidation Reduction (Ionic state becomes more positive) (Ionic state becomes more negative) Loses electrons Gains oxygen Loses oxygen Loses oxygen Loses hydrogen CHECKPOINT In the
following equation, is carbon oxidized or reduced? These, in turn, produce the voltages we have considered. An element is made up of only one type of atom. Helium, He, is a nonmetallic gas and the second element in the periodic table. 7.3 Radiation 9. Where are the great majority of stars plotted on an H-R diagram? Remember that water freezes at
the same temperature at which ice melts. As indicated by the cosmic background radiation, the distribution of energy within the expanded universe is remarkably uniform, but minor fluctuations still appear. m 40 kg LEARNING OBJECTIVE Specify the relationship between work and power. Drop a small bar magnet through a vertical plastic pipe,
noting its speed of fall. What you need: black felt-tip pen or black water, solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, table napkin, or coffee filter; solvent, such as paper towel, such as
coil. Pressure in a Liquid When you swim under water, you can feel the water pressure acting against your eardrums. F I G U R E 2.1 CHECKPOINT When a space shuttle travels in a nearly circular orbit around Earth, is a force required to maintain its high speed? From the hindsight of 20/20 vision, alcohols from biomass would have been a superior
choice environmentally, but they were banned by the prohibition movements of the loop, it must flow out the other end.) If the upper portion is forced to the left, then the loop is forced to the left, then the loop is forced to the right, as if it were a galvanometer. Use Newton's third law again: Yes, the
paper clip, as part of the interaction, certainly does exert a force on the magnet—just as much as the magnet pulls on it. Pipes drain the various liquid hydrocarbon fractions from the tower. The ball travels the same horizontal distance in equal times between each flash. FIGURE 10.39 The shock wave has not yet reached listener A, but it is now
reaching listener B, and it has already reached listener C. The rest is logic: Since the time of impusse is the same for both, which means they both undergo the same for both, which means they found, has the effect of fostering the growth of microorganisms
that enhance the rate at which carbon dioxide is absorbed. Alcohol evaporates quicker than water at the same temperature. 39. Scientific theories evolve as they go through stages of redefinition and refinement. The first human witnesses of the Moon's back were Apollo 8 astronauts, who orbited the Moon in 1968. FIGURE 3.9 The Pelton wheel. If the
temperature of the rising air becomes cooler than the surrounding air, it becomes denser and sinks back to the elevation where it started. Suppose that in 1 s, you steadily increase your velocity from 30 km/h. Briefly describe how thunder and lightning develop. 467: (right) M. We know from the law of universal gravitation that gravity
weakens with the inverse square of distance, so the side of the Moon nearer to Earth is gravitationally pulled more than the farther side. If one car is twice as massive as the other, how do their potential energies compare? When in motion, the ship may be raised or lowered by means of horizontal "elevators." Thus far we have treated pressure only as
it applies to stationary fluids. Anaerobic bacteria decompose organic matter in the absence of oxygen, resulting in methane, which is flammable, and foulsmelling nitrogen- and sulfurcontaining compounds. Hang time The time on a single
"ampoule" of fuel available at your local supermarket. Now we are at the point of wondering what might happen after eternal expansion. Name two mica minerals that can give a metamorphic rock its foliation. How about a mixture of iron and sand? The shell model is used to explain the organization of elements in the periodic table. 26.6 Failed Planet
Formation 25. 5 Projectile Motion 4. Much would have to happen, however, before we could convert from fossil fuels to hydrogen. Without external effort, the direction of heat flow is always from hot to cold. Today these paths are surprisingly simple when we look at the horizontal and vertical components of velocity separately. Temperature also
affects the ability of magma to flow. The air simultaneously pushes the bird upward. List these compounds in order of increasing boiling point: CI4, CB4, CF4. When sections of the plates become locked together, stress builds up until it is relieved in the form of an earthquake. Various distinct air masses cover large portions of Earth's surface.
In a pulley system, a larger fraction of input energy goes into heat. (e) The mineral hematite often grows in a grape-clustered form. For example, hydrogen, H2, reacts with oxygen, O2, to form water, H2O, as follows: HiH + HiOiH Note that the element hydrogen becomes attached to an oxygen atom through this reaction. The
source of all waves is a vibrating object. At the same time that we do work on one end of the lever, the other end does work on the load. Discuss why they would look entirely different from some other location in the universe, far distant from Earth. A rocket is thrust upward, for example, only as its exhaust chemicals are thrust downward. 2 E F E C
TSOFTHEDISCOVERY well be coal, oil, uraniOFTHREE NEW BOTTLES um, or any nonrenewTime Effect able resource. See also Neutron(s); Protons O Ocean(s), 647-653 deep-water currents in, 676 evolution of, 648-650 salinity of, 652-653 seawater and, 652-
653 shorelines and, 653-654 surface currents in, 672-675 tides and, 658-659 vertical structure of, 672 water circulation in, 671, 672 Ocean waves, 653-657 tsunami, 582-583 vibrations and, 239-240, 246-247 Oceanic-continental convergence, 569, 571 Oceanic-convergence, 571 Oceanic-convergence, 571 Oceanic-convergence, 571 Oceanic-conver
569-570 Ohm's law, 199-201 Oort clouds, 731 Opaque materials, 268 Orbits circular, 106-107 elliptical, 107-108 escape speed and, 109-111 planetary, 96 satellite, 104-108 Ordinary matter, 781 Ordovician period, 631 Organic chemistry, 489 Organic compounds, 489-518 alcohols, 497-499 alkaloids, 502 amines, 501 carbonyl groups of, 502-506
configurations of, 491 conformations of, 491 conformations of, 491 ethers, 500 functional groups in, 496-497 hydrocarbons, 490-496 monomers, 507 phenols, 499-500 polymers, 507-512 Original horizontality, rock dating and, 621 Orographic lifting, 694 Osmosis, 416 reverse, 416 Outer planets, 709, 710, 718-719 Oxidation, 470 Oxidation-reduction reactions, 454, 470-
482 in batteries, 473-476 combustion, 481-482 corrosion, 479-481 electric current and, 472-478 electrolysis, 478-479 in fuel cells, 476-477 Ozone, 629-630, 649 P Paleomagnetism, 563 Paleozoic era, 630-635 Pangaea, 633-639 breakup of, 635-639. The minimum energy required to overcome this energy barrier is known as the activation energy
(Ea). How much unpolarized light does an ideal Polaroid filter transmit? These factors in turn determine the arrangement of atoms in each mineral and the strength of the bonds that hold the atoms together. Your heart uses slightly more than 1 W of power in pumping blood through your body. Heavy nuclei can be made to fuse—for instance, by firing
one gold nucleus at another one. Are there galaxies other than the Milky Way that can be seen with the unaided eye? 701: NASA 707: Paul G. 12.6 Identifying Atoms Using the Spectroscope 16. The effect of expansion or compression of gases is quite impressive.* Atmospheric Stability Let's consider a parcel of air descending from aloft. Bases are
characterized by their bitter taste and slippery feel. (d) The wave model accounts for the shells that an electron may occupy, not its energy levels. (a) Cool (b) Medium (c) Hot F I G U R E 7.1 2 The frequencies and wavelengths of radiant energy levels.
one multiple covalent bond. This hope nurtured the thinking of many scientists, artists, writers, and philosophers of the 1700s. If you score less than 7, you need to study further before moving on. Warm, rising air creates a central low-pressure area that continuously draws more air toward the center of the disturbance. You can also look at it this way.
When you push a magnet into a coil, you induce electric current and cause the coil to become an electromagnet. Notice that this is the same way the Moon is lit by the Sun! For an example, see the photograph accompanying Exercise 67. Anything can pass into a black hole through its event horizon. Nitrogen is the solvent, because it is the component
that is present in the greatest quantity. In the orbiting space shuttle, you are handed two identical closed boxes, one filled with sand and the other filled with feathers. And on and on, one term building on another, as we attempt to describe the nature of matter beyond its casual appearance. Let Ohm's law guide your thinking. Material that escaped
bacterial decay was either preserved as sparsely distributed organic matter or converted to biochemical sediments to become coal, oil, or gas. Thus the transformation of methane to carbon dioxide and water is a chemical change, as are the other two transformations shown in Figure 14.8. The chemical change shown in Figure 14.10 occurs when an
electric current is passed through water. Why will this type of pickup fail with nylon strings? Why is Earth's crust thicker beneath a mountain? When a boat enters a caisson, the amount of water that overflows weighs exactly as much as the boat. When a boat enters a caisson, the amount of water that overflows weighs exactly as much as the boat.
density of 1 g/cm3. The atmosphere of Jupiter is more than 1000 km thick. The Moon has no atmosphere (because the escape velocity at the Moon's surface is less than the wave speed. Force is the same either way, but the corresponding
accelerations of each are different. Is the Local Group a relatively small or large cluster of galaxies? In the early 1980s, the Big Bang theory gained such a refinement from the insights of physicists Alan Guth and Andrei Linde (Figure 28.6). The coil turns against a spring, so the greater F I G U R E 9 .1 8 F I G U R E 9 .1 9 A very simple galvanometer.
Local Supercluster A cluster of galactic clusters in which our Local Group resides. They also have different horizontally. Evaporation The change of phase at the surface of a liquid as it passes to the gaseous phase. This has to do with the different orbital planes of Earth and the Moon. 5m 20 m CHECKPOINT
The boy on the tower in Figure 4.23 throws a ball 20 m downrange. Troops "break step" in order to avoid marching in rhythm with the natural frequency of the bridge—to prevent resonance. The force of gravity on a satellite 200 kilometers above Earth's surface is nearly as strong as it is at the surface. Rocks develop a distinct "foliated" texture.
which forms because of the great pressures generated by converging tectonic plates (Chapter 21). Nothing happens, because this arrangement results in a buildup of charge that prevents the further flow of electrons. Aha! Note that some frequencies simply cannot be whistled, no matter how hard you try. CHAPTER 20 1. 8 Ohm's Law 8. In this
analogy, we see here there is no "force" holding the marble to the ball. Likewise, nuclear reactions in Earth's interior warm Earth (visit the depths of any mine and you'll find that it's warm down there year-round). The crust is embedded in the rigid lithosphere, which floats on the plastic asthenosphere. LEARNING OBJECTIVE Relate a projectile
trajectory that matches Earth's curvature to satellite motion. The other sciences build on physics, not the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. A most important tool for either of these approaches is the scanning
probe microscope, which detects and characterizes the surface atoms of materials by way of an ultrathin probe tip, as shown in Figures 14.18 and 14.19. He found that all the energy goes into melting the ice. This one electron resides within the first
shell, which is the shell closest to the nucleus. The planar surfaces in a crystal form are the external shape from the crystal's internal arrangement of atoms. It helps to tap the material to nudge any stubborn domains into alignment. Does it follow that an observer on the Moon always sees the same face of Earth? Parallel Circuits A simple parallel
circuit is shown in Figure 8.30. Why is rock salt spread on icy roads in winter? Consider Michael Crichton's 2002 science-fiction novel Prey, in which self-replicating nanobots run amok turning everything they contact into a gray goo. Two metals that make for a good battery are copper and zinc, both of which are found in any post-1982 penny. Soon
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after Guth first recognized the significance of cosmic inflation, Linde followed through with many important refinements on the theory. The plates began to diverge apart from one another 30 million years ago. If you shake it up and down, the wave vibrates in a vertical plane. Both absorption and emission are illustrated in Figure 12.25. Can you see
the error in this argument? In balloons intended to reach very high altitudes or to remain aloft for a long time, helium is commonly used. Ultrasonic has to do with frequency—higher than we can hear. a Choose the BEST answer to each of the following. Processes in which disorder returns to order without external help don't occur in nature. Thus, there is a choose the BEST answer to each of the following.
term chemical change means the same thing as chemical reaction. How would society be able to support so many people living well into their 100s? One possible answer is the granitic Sierra Nevada range, which are the batholiths left over from subduction-derived partial melting and magma crystallization. 2 H2 

1 O2 2 H2O 2 moles 1 mole 2 moles
 which is which is which is 4g 32 g 36 g which is which is which is which is which is 12.04 1023 molecules 6.02 1023 molecules C H A P T E R 17 1 mole of carbon dioxide, CO2. Tl. . With scanning probe microscopy technology, we see not actual atoms but rather images of them. The half-life of an element can be calculated at any given moment
by measuring the rate of decay of a known quantity. Divide a ruler or a stick into five equal spaces. (b) volume of fluid. 2 Coulomb's Law 8. Rank the physical and chemical changes in order of the amount of energy released: (a) the condensation of rain in a thunderstorm, (b) the burning of a gallon of gasoline in a car engine, (c) the explosion of a
firecracker. If we can't see dark matter, how do we know it is there? This water can be piped to depths of hundreds of meters below sea level, whence it continues to flow toward the bottom of the ocean. Electromagnet A magnet whose field is produced by an electric current. A hydrocarbon structure can serve as a framework for the attachment of
various heteroatoms. Another example is an air conditioner, used in summertime to extract heat from indoors and move it to a warmer outdoors. That's why most chewing gums are hard until they soften up in your warm mouth. In a wire that carries 8 amperes, twice as many coulombs flow past any cross-section each second. Explain why freezing
rain is more commonly associated with warm fronts than with cold fronts. Jupiter also causes the collisions of asteroids, which then break apart into smaller fragments. The environmental lapse rate refers to the change of air temperature with altitude. If we look at distant dark mountains, very little light from them reaches us, and the
blueness of the atmosphere between us and the mountains predominates. These images are useful in diagnosing metabolic disorders. If the wall were made of this invisible matter you would be able to walk right through it. We know it's invisible matter you would be able to walk right through it.
speeds. At the farm, at ages 23 and 24, he laid the foundations for the work that was to make him immortal. The surrounding disk was the source of material that became the planets. F I G U R E 1 9.11 Ethanol can be synthesized from the unsaturated hydrocarbon ethene, with phosphoric acid as a catalyst. Poles of neighboring domains neutralize
each other's effects, except at the ends. When viewed from the North Pole, Earth spins counterclockwise, which is toward the east. How fast and in what direction should the mosquito fly in order to hover above you for lunch? Show that the impulse on a baseball that is hit with 100 N of force in a time of 0.5 s is 50 N # s. The addition of even a weak
acid, such as the acetic acid of vinegar, produces hydronium ions that react with the calcium carbonate to form several products, the most notable being carbon dioxide, which rapidly bubbles out of solution. When we apply the brakes to slow a moving car, we do work on it. It is easy to hide a lack of understanding by using big words with which
others are unfamiliar. He worked most of his life in the chemistry department of the University of California, Berkeley, where he was not only a productive researcher but also an exceptional teacher. Other communities ask their citizens not to sort at all, reasoning that the task of sorting inhibits people's tendency to recycle. In the scientific spirit, a
single verifiable experiment to the contrary outweighs any authority, regardless of reputation or the number of followers or advocates. Although reflection of each single ray obeys the law of reflection in many directions. If a bell is ringing inside
a bell jar, we can no longer hear it when the air is pumped out, but we can still see the bell. The Reading Check Questions are designed to help you comprehend ideas and catch the essentials of the chapter material. Rolled at the proper angle and speed (assuming no friction to slow it down), the marble could enter a perpetual orbit around the ball.
You can see the electrolysis of water by immersing the top of a disposable 9-V battery in salt water. The magnets must absorb energy if they are to break apart, and release energy as they come together. Why, then, doesn't a heavy body fall faster than a light body? Electrons Atomic nucleus F I G U R E 11. A lunar eclipse can be seen from the whole
hemisphere of Earth that faces the Moon. Instead, we develop models that provide a visual handle on the behavior of the components of atoms. Like two free-floating magnets coming together and accelerating to higher speeds, the potential energy of the reactants is converted to faster-moving atoms and molecules, electromagnetic radiation, or both
Seismic observations revealed that when P-waves reach this depth, they are reflected and refracted so strongly that the boundary actually casts a P-wave shadow over part of Earth (Figure 21.5). An electric potential of about CHAPTER 8 S TAT I C A N D CU R R E N T E L E C T R I CI T Y 205 ELECTRIC ENERGY AND TECHNOLOGY Try to imagine
everyday home life before the advent of electric energy. What he discovered next was most astonishing—the galaxies are all receding from one another. 2 Upon warming, the crystals collapse, resulting in a smaller volume for the liquid water. FYI 342 PA R T T W O CH E M I S T RY Before the development of the atomic bomb, the temperatures
required to Energy initiate nuclear fusion on Earth were unattainable. LEARNING OBJECTIVE Relate the specific heat capacity of substances to thermal inertia. To find the length of one "mole" of stacked pennies, take the number of FYI particles in 1 mole (6.02 * 1023) and divide it by the number of pennies in 1 cm. onsider a bug in the middle of a
quiet puddle. The inner planets formed from materials that remained solid at high temperatures; hence, the inner planets are rocky. A scuba diver breathes compressed air beneath the surface of water. FIGURE 9.27 When Jean Curtis powers the large coil with ac, an alternating magnetic field is established in the iron bar and thence through the
metal ring. What is meant by pseudoscience? Chemistry is often described as a central science because it touches all the other sciences. Assuming concentration necessarily decreases with increasing temperature. Physicists, for example, speak of the quark theory
of the atomic nucleus, chemists speak of the theory of metallic bonding in metals, and biologists speak of the cell theory. The relationship between primary voltage = Number of primary turns number of secondary turns It might seem that we get something
for nothing with a transformer that steps up the voltage, but we don't. The quantity that indicates how warm or cold an object is relative to some standard is called temperature. FYI 190 PA R T O N E P H Y S I CS IONIZED BRACELETS: SCIENCE OR PSEUDOSCIENCE? Solar cells can also supply the energy needed to produce hydrogen. One day he
rose and the house fell silent to hear the great man. FYI FIGURE 6.20 The six-sided structure of a snowflake is a result of the vibrational rate of electrons within the atom. 90. Iron has magnetic domains; wood does not. The amount of
energy released in an exothermic reaction depends on the amounts of the reactants. The term saturated means that each carbon has as many atoms bonded to it as possible. CHAPTER 4 4.3 G R AV I T Y, P R O J E C T I L E S, A N D S AT E L L I T E S Weight and Weightlessness EXPLAIN THIS How does your weight change when you're inside an
 acceler- 95 LEARNING OBJECTIVE Describe how weight is a support force. (The heated bar will be 100.6 m long.) 43. Notably, SBR is the key ingredient that allows bubbles to form in bubble gum. If they ever existed naturally when Earth was formed, they have long since decayed. Then, as water at the surface cools further, it floats on top and can
freeze. Similar effects occur for the interference of longitudinal sound waves, shown by the regions of compressions and rarefactions. Although Galileo founded the concepts of both inertia and acceleration and was the first to measure the acceleration of falling objects, he was unable to explain why objects of various masses fall with equal
accelerations. Science is concerned with gathering knowledge and organizing it. Our rate of rotation is much faster, so the Sun appears to move toward the west. Earth's tilt causes polar regions to have nearly 24 hours of sunlight (albeit dispersed sunlight) during half the year and nearly 24 hours of sunlight (albeit dispersed sunlight) and the west. Earth's tilt causes polar regions to have nearly 24 hours of sunlight (albeit dispersed sunlight) during half the year and nearly 24 hours of sunlight (albeit dispersed sunlight) and the west. Earth's tilt causes polar regions to have nearly 24 hours of sunlight (albeit dispersed sunlight) during half the year and nearly 24 hours of sunlight (albeit dispersed sunlight) and the west. Earth's tilt causes polar regions to have nearly 24 hours of sunlight (albeit dispersed sunlight) during half the year and nearly 24 hours of sunlight (albeit dispersed sunlight) and the west.
an anticline are the oldest, and away from the axis they get younger. Whereas electric charges can be isolated, magnetic poles cannot. Where are the Sun and the Moon located at the time of a new Moon? Place a pencil in your hand and put your palms together. Correspondingly, an electric field is induced in any region of space in which a magnetic
field is changing with time. Newton's three laws of motion are the foundation of present-day mechanics. Selective Transmission The color of a transparent object depends on the color of the light it transmits. What functional group must be removed in order to produce cadaverine, shown in Figure 19.16? The difference between referring to the
number of molecules of solute and referring to the number of grams of solute can be illustrated by the following question. Even frozen water undergoes sublimation. Surveys indicate that most Americans believe that ionized bracelets can reduce joint or muscle pain. Any events within the event horizon are invisible to distant observers. Like many
natural oils derived from fats, the carbons in cetyl alcohol are arranged in sequence with no branching. (b) only the energy of the electrons. If these are the only horizontal forces, with no external forces, with no exte
pointed, all the beams would be deflected into the black hole. If a falling object gains 10 m/s each second it falls, its acceleration is (a) 10 m/s. So sunsets would appear blue! 2. (a) The loop affixed to the post of a mechanical vibrator at rest. The force vector is maximum when the boat is at rest and the full impact of the wind fills the sail, and is
minimum when the boat travels as fast as the wind. What is the net charge of this atom? Knowing that waves travel faster in solids, we infer the existence of a solid inner core. FYI 506 PA R T T W O CH E M I S T RY acid and methanol is one example.
when we say a space shuttle travels at 30,000 km/h, we mean relative to Earth below. The electrons gained by \ge e_{\ell} chemicals are oxidized. As the temperature decreased, Humidity Saturation Vapor Pressure and the evaporation rate is greater than the condensation rate
Some don't know or understand the value of recycling. As slower-moving molecules are removed from the air, there is an increase in the average kinetic energy of molecules that remain in the air, there is an increase in the average kinetic energy of molecules that remain in the air. The lone electron pair on nitrogen atoms makes them basic because this pair is able to accept a hydrogen ion. Their discovery changed the world by
making electricity commonplace—powering industries by day and lighting up cities at night. Other common sources are white-hot filaments in lightbulbs, glowing gases in glass tubes, and flames. High-speed ions ejected from the Sun stir up the ionosphere. In order to slide a heavy cabinet across the floor at constant speed, you exert a horizontal
force of 550 N. The jet streams are high-speed winds in the upper troposphere. In a solution, all compoGranite "Snow" in snow globe Pizza nents are in the same phase. Tornadoes occur in many parts of the world. THINKANDSOLVE (MATHEMATICALAPPLICATION) 44. This process, known as carbon-14 dating, enables us to
probe as C H A P T E R 13 T H E ATO M I C N U CL EU S A N D R A D I OAC T I V I T Y 333 17,190 years ago 5730 y
ideas were accepted. Why isn't this bending taken into consideration by surveyors who use laser beams as straight lines? Middle clouds (2000-6000 m) 4. Instead, it acts perpendicularly both to the magnetic field and to the electron beam. There is no temperature difference between your hand and forehead. Hewitt (left) Rachel Epstein/ PhotoEdit Inc
As you leave your air-conditioned room, the warm air outside comes in contact with the cold surface of the sunglasses. Does condensation occur more readily at high temperatures? Note that the physics is the same as the physics is the same as the physics of Figures 4.14 through 4.16. The elemental formula S8 indicates that there are eight atoms in the
sulfur molecule. ** This is true even though beta particles have more penetrating power, as discussed earlier. CHECKPOINT If the bacteria growth continues at the unchanged rate, what time will it be when the three new bottles are filled to capacity? The amount of radiation emitted also depends on surface characteristics, which determine the
 emissivity of the object—ranging from close to 0 for very shiny surfaces and close to 1 for very black ones. Heat flow from the core to the mantle is mostly due to conduction. The fluids in the rock, which are enclosed in pore spaces, can act as catalysts to initiate or speed up metamorphic reactions. They play no role in accelerating the system. 3 2
INTERACTIVE FIGURE can see that a circle is a special case of an ellipse. Friction plays no role unless the book slides or tends to slide along the table surface features. If the stream channel is unchanged, then discharge and stream speed increase. Because the
can has a fixed volume, the walls of the can don't move, so no work is done. * In hospitals, concentrated beams of ultrasound are used to break up kidney stones and gallstones, eliminating the need for surgery. Many seashells are composed of calcium carbonate secreted by organisms. Both these isotopes can chemically react with oxygen to form
carbon dioxide, which is taken in by plants. Mass has the effect of curving spacetime. N E W TO N 'S L AW S O F M OT I O N 51 FIGURE 2.27 INTERACTIVE FIGURE An external horizontal force occurs when the floor pushes on the apple (reaction to the apple 's push on the floor). If our species lasts that long! 754 PA R T F O U R ASTRONOMY 6
billion km in diameter, which is as large as our solar system! The origin of this mega black hole is likely related to the formation of the galaxy itself. Which would you expect to be more viscous: a polymer made of short molecular strands or one made of short molecular strands? You can safely walk barefoot across red-hot wooden coals if you step quickly
because very little heat is conducted to your feet. The lobe-finned fishes evolved internal nostrils, which enabled some species to breathe air. Because 1 mole of any substance always contains 6.02 * 1023 particles, the mole is an ideal unit for chemical reactions. What produces acceleration? (a) Use Newton's second law and show that the acceleration
of the cart is (F - f)/m. See the activities at the end of this chapter to understand why. Brittle deformation occurs near the surface where temperature and pressure are low; it produces faults and fractured rocks. Schists are named according to the major minerals in the rock (biotite schist, staurolite-garnet schist, and so on). Although bimetallic strips
nicely illustrate practical physics, electronic sensors now replace them in thermostats and many other thermal devices. When a sugar solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, some of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, so the sugar usually comes of the sugar usually comes out of solution saturated at a high temperature is allowed to cool, so the sugar usually comes of the sugar usua
this chapter, we explore three types of chemical bonds: the ionic bond, which holds atoms together in a molecule. The concentration of hydronium ions in the pH = 1 solution is 0.1 M. (a) Natural Transmutation Consider
uranium-238, the nucleus of which contains 92 protons and 146 neutrons. Assume that air resistance is negligible. When the water is warm, place a saucer filled with ice cubes on top of the container. All ura- 1/8 kg nium eventually decays in a series of steps to lead. No, unless you're an airhead (having a head mass about the same as that of an air-
filled balloon). One chlorine atom in the ozone layer is estimated to catalyze the transformation of 100,000 ozone molecules to oxygen molecules in the one or two years before the chlorine atom is removed by natural processes. 382 PA R T T W O CH E M I S T RY FIGURE 15.24 Ionic The ionic bond and the nonpolar covalent bond represent the two
extremes of chemical bonding. When the balloon is in equilibrium, its buoyant force equals its weight, 1 N. (The slightly negative side of the oxygen molecule is shown larger than the slightly negative side because the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side because the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the oxygen molecule is shown larger than the slightly negative side of the oxygen molecule is shown larger than the oxygen molecule is shown larger than the oxygen
an oxygen molecule change when the hydrogen side of a water molecule is nearby? It takes 4.19 J (or equivalently, 1 calorie) of heat to change the temperature of 1 g of water by 1°C.* The energy ratings of foods and fuels are determined from the energy released when they are burned. Contrast Newton's approach with the failure to "do one's
homework," the hasty judgments, and the absence of cross-checking that so often characterize the pronouncements of people advocating less-than-scientific theories. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Force pair The action and reaction pair of forces that occur in an
interaction. Pelton recognized a problem with the flat paddles on the waterwheels. Pretend that while you are at a social gathering, you make several momentary stops across the room to greet people who are "on your wavelength." How is this analogous to light traveling through glass? If the charges attracting each other in the preceding problem
have equal magnitudes, show that each charge has a magnitude of 1.9 microcoulombs (1.9 * 10-6 C). He could weight of fluid equal to its own weight. If we immerse it completely (submerge it), it is buoyed up by the weight of a full liter (or 1 kg) of water. On a warm day, the air near the ground
may be appreciably warmer than the air above, so the speed of sound near the ground increases. So we'll end up with 100 g of 30°C water. (c) more slippery. Not so! There is no center to the surface of the balloon, just as there are no edges. (a) (b) Point opposite window F I G U R E 2 8 .1 2 Deflection Light strikes here (a) (b) Consider a ball thrown
sideways in a stationary spaceship in the absence of gravity. A friend says that astronauts inside the International Space Station are weightless because they're beyond the pull of Earth's gravity. Detergents are cheaper than soaps. On which temperature scale does the average kinetic energy of molecules double when the temperature doubles? What
is the acceleration of a falling object that has reached its terminal velocity? Would you describe this as a polar or nonpolar situation? A stack containing "1 mole" of pennies would reach a height of about 860 quadrillion km, which is roughly equal to the diameter of our galaxy, the Milky Way. 532 PARTHREEEARTHSCIENCECTYSTAILIZATION
in Water Solutions F I G U R E 2 0 .1 4 Calcium carbonate precipitating from dripping water in a cave forms icicle-shaped stalactites hanging down from the ceiling and coneshaped stalagmites protruding upward from the ground. Transmutation The changing of an atomic nucleus of one element into an atomic nucleus of another element through a
decrease or increase in the number of protons. This happens when the gravitational force pulling the ship downward (its weight) equals the buoyant force pushing it upward (Figure 21.8). 3 3 (a) In a mixture of ice and water at 0°C, ice crystals gain and lose water molecules at the same time. A gap is usually provided by an electric switch that can be
opened or closed to either cut off energy or allow energy to flow. Worse still, excessive fluoride binds with calcium in your blood, forming lethal calcium fluoride crystals. Unless you cover only a few Chapters in your course, you will likely be expected to tackle only a few Think and Solves, Exercises, and Discussion Questions for each chapter. The
Scientific Attitude EXPLAIN THIS Why does falsifying information discredit a scientist but not a lawyer? Over the last 500,000 years the average temperature of Earth has fluctuated between 19°C and is presently at the high point, 27°C—and climbing. 7 8 PROLOGUE THEN AT URE OF SCIENCE The belief that there is only one truth
and that oneself is in possession of it seems to me the deepest root of all the evil that is in the world. To see red light, one must look to a drop higher in the sky. Both half reactions are required to represent the whole oxidation-reduction process. If the remaining 100% - (4% + 23%) = 73% of matter could be accounted for, then the mass of the
universe would be sufficient to one day halt the expansion. Each pivot wets the felt surface of the beak and head, and the cycle is repeated. This energy is available when the positions of electric charges within and between molecules are altered—that is, when a chemical change occurs. These energy-rich molecules CHAP TER 26 are the primary
energy source for almost all the organisms of this planet. The star has moved westward. When blood pressure is measured, notice that it is done in your upper arm—level with your heart. A tiny fraction of the Sun's energy reaches Earth and is converted by photosynthesizing organisms to chemical energy stored in large molecules. Think and Solve
(Mathematical Application) The Think and Solve questions blend simple mathematics with concepts. The High Specific Heat Capacity of Water Water has a much higher capacity for storing thermal energy than almost any other substance. To be so hot and radiate so little light, these stars must be very small—they are called the white dwarfs. This
separation of charge is called a dipole (pronounced die-pole) and is represented either by the characters d - and d + (read "slightly positive," respectively) or by a crossed arrow pointing to the negative side of the bond: δ - H F H F So atoms forming a chemical bond engage in a tug-of-war for electrons. (c) formation of pore
 water. CHECKPOINT If the speed of light were the same in air of various temperatures and densities, would there still be slightly longer daytimes, twinkling stars at night, mirages, and slightly squashed suns at sunset? The net speed, or drift speed, or 
from which Western science later arose. Today, landings on Mars show it to be a very dry and windy place. His revolutionary answer was that every particle of matter is somehow Recall from Chapter 11 that a photon behaves like a particle when it is being emitted by an atom or being absorbed by photographic film or other detectors, but it behaves
like a wave in traveling from a source to the place where it is detected. Note the remarkable resolution. 176). 758 PARTFOURASTRONOMYFIGURE 27. (Gibbous means "more than half.") We see a full Moon when the sunlit side of the Moon faces us squarely (position 5 in Figure 26.25). What is terrestrial radiation? The density of any amount
of water is the same: 1 g/cm 3 or, equivalently, 1000 kg/m 3, which means that the mass of water that would be 1 g; or the mass of water that would be 1 g; or the mass of water that would be 1 g; or the mass of water that would be 1 g; or the mass of water that would be 1 mass of water that would be 1 g; or the mass of water that would be 1 g; or the mass of water that would be 1 g; or the mass of water that would be 1 mass of water that would be 1 g; or the mass of water that would be 1 mass of water than would be 1 mass of water that would be 1 mass of water that would be 1 mass of water than would be 1 mass of water that would be 1 mass of water than would be 1 mass of water than woul
The second law, like the first, makes logical sense.** The third law of thermodynamics restates what we've learned about the lowest limit of temperature: No system must also be zero for mechanical equilibrium. Compression causes the plates to break and fold up on each other, making
the crust very thick. The loss of potential energy is balanced by a gain in kinetic energy. (b) resistance. (b) 35 N east. G L O S S A RY Quality The characteristic timbre of a musical sound, which is governed by the number and relative intensities of partial tones. Why is the boiling point of water so much higher than that of methane? Plumbers got their
name because they once worked with lead pipes. At the same time, air dissolves into the water, giving it a better taste—without dissolved air, the water taste flat. Is Earth's interior mostly magma? A proton has nearly 2000 times the mass of an electron, but its positive charge is equal in magnitude to the negative charge of the electron. Recent
evidence discovered by neutrino research in 2011 indicates that a major source of Earth's internal energy, perhaps half, is due to nuclear fission within Earth's core. Of these three isotopes, hydrogen-1 is most common. But learning about the molecular nature of our environment is valuable for more than just the mental exercise. This occurs about
two times per year, which is why there are at least two solar eclipses per year (visible from only certain locations on Earth). Dark matter stays clumped together by way of this "force" of gravity. We know that a cannonball fired horizontally at 8 km/s from Newton's mountain would find itself in orbit. Because the total supply is the same in both cases
space of the 775 LEARNING OBJECTIVE Identify three successes of the theory of cosmic inflation. Natural background (cosmic rays, Earth minerals) 81% Medicine and diagnostics 15% Consumer products (television sets, smoke detectors) 4% F I G U R E 1 3 .1 Origins of radiation exposure for an average individual in the United States. If you call
4, 2012 Apr. If a golf ball and a Ping-Pong ball move with the same KE, can you say which has the greater speed? The free-base form of the alkaloid caffeine is readily soluble in diethyl ether but not in water. Bells and tuning forks, of course, vibrate at their own characteristic frequencies. These include sunscreens, mirrors that don't fog, dental
bonding agents, automotive catalytic converters, stain-free clothing, water filtration systems, the heads of computer hard drives, and many more. Why is lead found in all deposits of uranium ores? Amphoteric Description of a substance that can behave as either an acid or a base. Even the tiniest of sparks ignite vapors coming from the gasoline and
 Advances in Science 2. Why can you exert greater force on the pedals of a bicycle if you pull up on the handlebars? A mountain-climber of mass 80 kg ponders the idea of attaching a helium-filled balloon to himself to effectively reduce his weight by 25% when he climbs. But the final instantaneous speeds (not the times) are the same because the
molecules shown in Figures 15.17 through 15.19 and Figure 15.21, letting the different colors represent different colors represen
very little HCl remains (none shown here) lets us know that HCl acts as a strong acid. It is common to say that energy is used up when it is transformed to less concentrated forms—when it is degraded. 65. b a c When a moving billiard ball has a head-on collision with another billiard ball at rest, the moving ball comes to rest and the other ball moves
 "resistant." A beautician can control how long hair retains artificial coloring by modifying the pH of the hair-coloring solution. All questions were then organized following Bloom's taxonomy of learning as follows: Summary of Terms (Knowledge) The definitions have been edited to match the definitions given within the chapter. Note that in a curved A
virtual image is formed behind the mirror, unlike in a plane mirror, the normals (shown by the dashed black lines) tion where the extended reflected at different points on the surface are not parallel to one another. In the absence of work input or output or other energy exchanges, the total energy of a system before
 some process or event is equal to the total energy after. 704 PA R T T H R E E E A R T H S CI E N CE 12. As the oceans disappear, carbon dioxide levels will also rise dramatically, ensuring that the greenhouse effect keeps the water vaporized. Lift is greater when there is a large wing area and when the plane is traveling fast. A satellite 5 km above
Earth's surface is still in considerable atmosphere as well as in the range of some mountain peaks. Why do the passengers in high-altitude jet planes feel the sensation of weight while passengers in the International Space Station do not? 103. The Church, the dominant political and cultural force in Western Europe, at first prohibited the works of
Aristotle and then accepted and incorporated them into Christian doctrine. 8.3 Electric Field EXPLAIN THIS E What kind of force field surrounds mass? Six liters per minute (10 L - 4 L = 6 L). A neutral atom has as many electrons as protons, so it has no net charge. * A general law that takes temperature changes into account is P1V1 >T1 = P2V2
>T2, where T1 and T2 represent the initial and final absolute temperatures, measured in SI units called kelvins (see Chapter 6). Because the strong + + + All nucleons, both protons and neutrons, attract one another by the strong + + + All nucleons, both protons and neutrons, attract one another by the strong + + + All nucleons, both protons and neutrons, attract one another by the strong nuclear force.
can say* Peg FIGURE 3.22 INTERACTIVE FIGURE The pendulum bob will swing to its original height whether or not the peg is present. With the exception of hydrogen, therefore, all the atoms that occur naturally on Earth—including those in your body—are the products of stars. In synchronized diving, divers remain in the air for the same time.
Because of this history, group 1 elements, which are metals, are called the alkali metals. If the relative humidity is 40%, what is the mass of water vapor in 1 m3 of air? What products are formed when sodium hydroxide accepts a hydrogen ion from a water molecule? This behavior—the ability of rocks to flow without breaking—is called plasticity.
Heat loss by radiation is inhibited by the silvered surfaces of the walls, which reflect radiant energy back into the bottle. T H I N K A N D R A N K (A N A LY S I S) 34. Different frequencies of light are perceived as different colors; the lowest frequencies of light are perceived as different colors; the lowest frequencies of light are perceived as different colors; the lowest frequency we see appears, to most people, as the color red, and the highest appears as violet.
where precision is needed, we round off 9.8 and call it 10. Is the mass of a nucleon inside a nucleon outside a nucleon 
To be a mineral, it must be naturally formed. The lithosphere is about 100 km thick and includes the entire crust Moho 0 Lithosphere (rigid) 200 400 600 Depth (km) The Mantle The discovery of magnetic-pole reversals helped explain the motion of the continents. (b) half as much. Minerals that contain metals
tend to have a shiny luster. Carbon-14 is a beta emitter and decays back to nitrogen by the following reaction: 7 7 6 8 14 6 C 14 7 N 0 -1 e Because plants continue to take in carbon-14 from the atmosphere. The bits of thread become polarized in the
electric field, one end positive and the other negative, and become the electric counterparts of the magnetic compass. When fast-moving ones. 2 9 Heating warms the water from below, and boiling cools it from above. The star then has a structure
consisting of concentric shells. One source of this acidity is carbon dioxide, the same gas that gives fizz to soda drinks. In the 1950s, a plot of the position of the positions of the magnetic north pole throughout the world (Figure 21.14). The point
here is that there isn't much time between the moment that the effects of growth become noticeable and the time when they become overwhelming. The anesthetic properties of this compounds—those consisting of only
carbon and hydrogen. Bond polarity can be inferred by looking at the relative positions H He — 2.2 Li Be B C N O F 0.98 1.57 2.04 2.55 3.04 3.44 3.98 — Na Mg Al Si P S Cl Ar 1.61 1.9 2.19 2.58 3.16 — Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr 0.93 K FIGURE 15.22 The experimentally measured electronegativities of elements. If it is two materials,
coming "out of solution" in the form of rain or snow is called "precipitation." The rain or snow is the "precipitate. Instead, learning some guidelines will prove most helpful. (d) an outward spiral path. This law tells us, for example, that if one galaxy is twice as far away as another, the farther galaxy recedes twice as fast from us. How might this odor be
removed from water already taken from the tap? 612: (b) Jsuyk/Shutterstock 613: Leslie A. The north and south poles of a magnet are like the head and tail of the same coin. Symbolically, a & F/m. A binary star is a double star—a system of two stars that revolve about a common center, just as Earth and the Moon
revolve about each other. The small lithium disposable batteries used for calculators and cameras are variations of the alkaline battery. Do you agree or disagree? The seawater that does not freeze experiences an increase in salinity, which in turn brings about an increase in density. The satellite has its highest speed as it whips around A and has its
lowest speed at position C. At this temperature, molecules have lost all available kinetic energy.* No more energy can be removed from a substance at absolute zero. C H A P T E R 15 H O W ATO M S B O N D A N D M O L E CU L E S AT T R AC T 369 FIGURE 15.2 1 2 13 14 15 16 17 Li . Coarse-grained plutonic igneous rocks are created because (a)
lava intrudes deep into Earth's interior. If dark energy turns out to be the "antigravity," remember that gravity itself is best described not as a "force" but as a warping of spacetime. The valence electrons of a potassium atom are weakly held by the nucleus. v 3.00 * 108 m/s 300,000,000 km distance 41. FYI The differences between how P-waves and
S-waves move through Earth's interior. The tension would be half your weight in each rope. Asteroids orbit (a) the Moon. Action and reaction always act on different objects. The largest mass extinction of them all, however, was the Ordovican mass extinction of them all, however, was the Ordovican mass extinction of them all reaction always act on different objects. The largest mass extinction of them all, however, was the Ordovican mass extinction of them all reaction always act on different objects.
otherwise. Your friend of mass 100 kg can just barely float in fresh water. Laser Detector Display Cantilever Computer Sample Probe tip C H A P T E R 14 The ultimate expert on nanotechnology is nature. In each succeeding second of fall, you'd find the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules and the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount: 10 m/s. For example, if just one atom or molecules are not provided in the boulder's speed increasing by the same amount.
out of a trillion trillion were different, then the LEARNING OBJECTIVE Classify the states of matter under the categories of pure and impure. (b) half your weight. For example, if you study quantum physics you'll learn that it is not possible to know with certainty both the momentum and position * Of course, this does not apply to certain religious
extremists who steadfastly assert that one cannot embrace both science and their brand of religion. Might there be a greater emphasis on "privatized retirement accounts"? Here we see a shallow dish of room-temperature water propels the
fish forward. (2) As hard water passes over the resin, sodium ions are displaced by calcium and magnesium ions. Equatorial regions spin once in 25 days, but higher latitudes take up to 36 days to make a complete rotation. Several steps need to happen for a cloud to fully develop. As buried organicrich sediment is heated over time, chemical changes
take place that create oil. 4.3 Weight and Weightlessness 8. Dear friends from John's years teaching in Hawaii includes the cooling down of a hot pan entropy will not likely occur. Would it be correct to say that equal forces of gravity act on both the coin and the
feather in a vacuum? You soon realize, however, that you're a lousy salesperson and all the other vendors at the convention are excellent salespeople. Yes, countries and industries have the capability to self-regulate, but forces being what they are, this self-regulation is not always ideal for everyone. An important difference between water flow and
 electron flow has to do with their conductors. (The most common isotope, carbon-12, has six neutrons and is not radioactive.) Because both carbon-12 and carbon-14 are forms of carbon, they have the same chemical properties. Which gets to
the end first, however, is a different question! (Ball B wins due to its greater average speed.) 101. Why do heteroatoms make such a difference in the physical and chemical properties of an organic molecule? Water also takes longer to cool. Figure B.8 shows the force at the wheel's center. 9 Bernoulli's Principle to flow; hence, they are called fluids.
Dissolving The process of mixing a solute in a solvent to produce a homogeneous mixture. FYI Three Types of Magma, Three Major Igneous Rocks There are three major types of magma—basaltic, and granitic. The most common granular minerals found in gneiss are quartz and feldspar. Thus, there are 26 protons in an iron atom. The speed
of the satellite must be great enough to ensure that its falling distance matches Earth's curvature. When you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit, you double the voltage in a simple electric circuit.
Then the two atoms are held together in a fluorine molecule by the attraction they both have for the granite because the sandstone had to be there in order for the granite to cut through it. Liquids and gases are both fluids. It may change form or it may simply be
transferred from one place to another, but the total energy score stays the same. The coil is mounted for movement, and the magnet is held stationary. 7 Blow warm air onto your wide-open mouth. Where did the carbon atoms in Leslie's hair originate? Continental margin The boundary between the continents and the ocean; it consists
of a continental shelf, a continental shelf, a continental slope, and a continental rise. Each sphere is separate, but each sphere is separate, but each sphere touches and is interconnected to the other sphere is separate, but each sphere is separa
materials. Baird/Paul G. 734 PA R T F O U R ASTRONOMY 32. The bow can do work on the arrow. Some old Christmas tree lights are connected in series. The farther away the object, the older it is. What happens to the density? 9 The Shell Model with the materials around us and used them to our advantage. The answer was provided in 1831 by two
physicists, Michael Faraday in England and Joseph Henry in the United States—each working without knowledge of the other. Event horizon The boundary region of a black hole from which no radiation may escape. As a result, their crystalline structure and the properties they display are different. Or would you expect different ions to be bent by
different amounts? Electron gains potential energy and moves farther from nucleus. Pure table salt contains nothing but the compound sodium chloride. The work that is done (by whatever means) in separating the opposite charges is available at the terminals of the battery or generator. A ball is thrown straight up with enough speed so that it is in
the air for several seconds. Because electrons are so much less massive than protons and neutrons, their contribution to atomic mass is negligible. As we discuss next, the molecules of a nonpolar material with zero electrical resistance, in which electrons
flow without losing energy and without generating heat. 5 6 Polaroid sunglasses block out horizontally vibrating light. Astronauts returning from extended space visits may be up to 2 inches taller upon their return. The bonds in N2 and O2 molecules, for example, are quite strong. If a good absorber of radiant energy were a poor emitter, how would
its temperature compare with the temperature of its surroundings? If you study earthquakes, you'll learn about two types of waves that travel in the ground. He died four years later. When the iron boat displaces a weight of water equal to its own weight, it floats. TUTORIAL: Introduction to Organic Molecules TUTORIAL: Organic Molecules and
Isomers Hydrocarbons 19.1 EXPLAIN THIS How is a road like an oil spill? This is a small-scale version of pushing a friend on a swing—it's the timing that's important. Atmospheric pressure on the surface of the water simply pushes the water up into the region of reduced pressure inside the pipe. Must people choose between science and religion? In
fact, the question cannot be answered unless you have more information. Streak can be used for identifying minerals that The mineral corundum (Al2O3) have a metallic or semi-metallic luster. The superdense neutron core that remains after the supernova is called a neutron star. 5 Ear th's Moon 26. How much distilled water are you able to collect
per ice cube? S-waves cannot travel through liquids, implying that the outer core is liquid. So cubic zirconia and other synthetic gems are not minerals. Parallel circuit An electric circuit with two or more devices connected in such a way that the same voltage acts across each one, and any single one completes the circuit independently of all the
cells transform sunlight to electricity. As for a water wave, the high points are called crests, and the low points is moved horizontally at constant are the troughs. Radon is a heavy gas that tends to accumulate in basements after it seeps up through cracks in the floor. Look for the Moon the next night at the same time, and you'll see that it has moved
eastward (a counterclockwise direction) from where it was on the previous night. Though we know it is imaginary, the celestial sphere is still a useful construction for visualizing the motions of the gases accumulated in
your gut simply pass out the opposite end of your mouth, assuming you haven't burped. Except for light that hits vertically, the reflected ray has more vibrations parallel to the reflecting surface. This does not contradict the law of energy conservation because energy is dissipated from the moving-snowball system, not destroyed. If star A is 100 lights that hits vertically, the reflected ray has more vibrations parallel to the reflecting surface.
years away, how far away is star B? When a stone is submerged, it displaces a volume of the stone. Generating pressures greater than this has its share of technical difficulties and is an energy-intensive process. The periodic table is a road map to understanding the elements. The answer is, it flattens. In a similar fashion,
as discussed in Chapter 12, everything around us—no matter how smooth it may appear—is made of the basic units you know as atoms. A system may be as tiny as an atom or as large as the universe. (b) How much force does the ball exert on the pillow? The majority of the acetic acid molecules remain in their non-ionized form, which implies that
acetic acid is a weak acid. Added heat that doesn't raise the temperature increases the thermal energy of the system and/or does external work if it leaves the system. We also know that atoms differ from one another only in the number of subatomic particles they contain. What is important to understand here is that there is no black-and-white
distinction between ionic and covalent bonds. CHAPTER 6 T H E R M A L E N E R G Y A N D T H E R M O DY N A M I CS 153 We can think of specific heat capacity as thermal inertia. But, if we say it moves at 60 km/h to the north, we specify its velocity. When the light reaches the opposite side of the drop, each color is partly refracted out into the air
the Army, I tried my luck at sign painting, and the cold Boston winters drove me south to Miami, Florida. (a) Helium, argon, aluminum. 187 LEARNING OBJECTIVE Describe the conditions by which an object acquires a net charge. (d) Today's instruments are able to measure the atomic masses to many decimal places. With no water available to
dissolve this material, it precipitates out of the diethyl ether as a solid that may be collected by filtration. The sound produced is not as full and not as loud as from speakers properly connected in phase. This initial stage occurs at the polar front at a location with the characteristics of a stationary front, where both air masses are moving parallel to the
front (Figure 25.15a). What is the law of reflection? Inside the building, the 240 V can divide to a safer 120 V. The red gases above and below the galactic plane are primarily hydrogen being pushed out by abundant stellar wind. Magnetic field Beam * When particles of electric charge q and velocity v move perpendicularly into a magnetic field of
strength B, the force F on each particle is simply the product of the three variables: F = qvB. An artist wants to create a metal sculpture using a mold so that his artwork can be readily mass produced. But a computer need not rely on an integrated circuit of nanowires for processing power. Beneath the complexities of electrical phenomena lies a
 fundamental rule from which nearly all other electrical effects stem. Look at Figure 21.34; can you see how tension extends and elongates the crust? Both bottles are then tightly resealed. Similarly, mass causes spacetime to curve in such a way that parallel lines could eventually merge. 41 Node Node 3rd harmonic 256 PARTONEPHYSICS
that normally hang straight down spread apart. When the object and the thermometer have the same average kinetic ener(c) Vibrational motion gy per particle, we say that they are in thermal * Okay, if you really want to know, the formulas for temperature conversion are C = 59 (F - 32) and F = 95 C + 32, where C = 59 is the Celsius temperature and E = 59 is the Celsius temperature and E = 59 is the Celsius temperature conversion are E = 59 is the Celsius temperature and E = 59 is the Celsius temperature an
the Fahrenheit temperature. With a pair of tongs, invert the can into a pan of cool water. But a rising air parcel must do work on the surrounding environment in order to expand. Listener C has already heard it, and listener A will hear it shortly. So the only way to separate an element from a compound is by chemical means. All the physics occurs in
steps (a) and (b) in Sample Problem 1. The scaffold must weigh 300 N (800 N - 500 N = 300 N). Third law of thermodynamics No system can reach absolute zero. As in the preceding exercise, radar waves are reflected from moving balls. This particle is vibrating back and forth between what? Kinetic energy = Law of conservation of momentum In the
 absence of an external force, the momentum of a system remains unchanged. We will go into more detail about the crystalline structures of minerals with the highest solubility (d) minerals with high silica content 5. Radiation is indeed
everywhere. To help overcome obstacles such as these, there can be campaigns to educate the general public. (b) Blood is a suspension, an example of a homogeneous mixture. The Moon is similarly lit by the Sun. Water in an elevated reservoir and the raised ram of a pile driver both have gravitational potential energy. But, since the masses are
plane if the wind is head-on? In such a halogen bulb, the evaporated tungsten combines with the halogen rather than depositing on the bulb, which remains clear. Ignore air resistance. Many solar eclipse enthusiasts travel the world to view this inspiring natural phenomenon. In the early 1990s, an antiwater-chlorination campaign in Peru led the
 across it equals that of the battery. The geosphere is the rocks and minerals that make up our planet, and their relationship to Earth's internal and external processes. Hewitt 144: (left, right) Paul G. (Such propeller-driven boats are used in very shallow water, as in the Florida Everglades.) If the fan is not turned around, the boat is propelled
backward, to the left. A weak acid is added to a concentrated solution of hydrochloric acid. Which provides the most dietary Calories per gram? FYI This is stated in the equation of continuity: A1v1 = A2v2 The product A1v1 at point 1 equals the product A1v1 at point 2. When lift is greater, the helicopter climbs upward. a, 7. This is why most winest winest acid.
 have an alcohol content of about 12% —they are produced solely by fermentation. What is the chemical structure for this tri-alcohol? We say these moons are "tidally locked." (a) Torque (b) No torque FIGURE 26.28 (a) When the compass needle is not aligned with the magnetic field (dashed lines), the forces represented by the blue arrows at either
end produce a pair of torques that rotate the needle. (Use this example if you wish to explain to someone the difference between speed and acceleration.) 99. CHAPTER 1 72. The projectile returns at the same speed of 100 m/s, as indicated in Figure 4.22. Twice as much kinetic energy means that it has twice the absolute temperature, or two times
273 K. It doesn't because you are also traveling at the same speed, before, during, and after your jump. (b) The bulk of a high-formula-mass alcohol likely consists of nonpolar hydrocarbons. In the preceding question, in which of the cases a, b, or c is the greatest impulse required? From F = G 2, F = G = G 2, which means d d2 d mM the force of
gravity between them is 4 times greater. See also Big Bang Big Rip and, 785-787 dark energy and, 785-787 heat death and, 785-787 heat death and, 785-786 relativity and, 768, 777-790 Sparks, 189 Special theory of relativity, 781 Specific heat capacity, 151-
154 Spectroscopy, 308-309 Speed, 24-27 average, 25-26 escape, 109-111 instantaneous, 25 of light, 267 of sound, 243 terminal, 44-45 units of, 25 Spiral galaxies, 757-758 Stargazing, 739-740 Stars, 738-767 brightness of, 741-744 constellations of, 739 in
galaxies, 754-767. (b) When its end is shaken up and down (or side to side), a transverse wave is produced. He expressed it in his second law of motion. 17.3 Reaction Rates 13. Eventually, all the sites for calcium and magnesium on the resin are filled, and then the resin needs to be either discarded or recharged. The more transistors they could
squeeze into a circuit, the more powerful the logic board. The oil in turn transmits the pressure to a piston, which lifts the automobile. What are the consequences of galaxies colliding? Suggest why. FYI Elliptical, Spiral, and Irregular Galaxies The millions of galaxies visible in photographs can be separated into three main classes—elliptical, spiral,
and irregular. FYI 360 PA R T T W O CH E M I S T RY F I G U R E 1 4 .1 7 Carbon nanotubes can be nested within each other to provide the strongest fiber known—a thread 1 mm in diameter can support a weight of about 13,000 lb. (c) is highly complex and appears to have been built by chaotic processes. What is the chemical name for a compound
with the formula Ba3N2? About one-quarter of the steel produced in the United States, for example, goes into replacing corroded iron at a cost of billions of dollars annually. How are military people able to see enemy combatants in complete darkness? Which of these cases illustrates the weight of the ball, and which illustrates the mass of the ball?
Would its tension decrease? The net result is that for every calcium or magnesium ion that binds, two sodium ions are set free. The Moon is going through its waxing gibbous phase (position 4 in Figure 26.25). Each fold Axis of anticline has an axis, with the rock layers on one side of the axis a mirror Axis of syncline image of the rock layers on the
other side. This creates stress. When viewed through a spectroscope, the color of each element is revealed to consist of a pattern of distinct frequencies known as an atomic spectrum. Stepping off the top of a stepladder, you would be only momentarily weightless because of a momentary lapse of support force. A hydrogen ion, H+, formed from the
loss of an electron, therefore, is nothing more than a lone proton. Within each of the four red dust clouds are developing stars. Bare parts show where heat from the inside has conducted through the roof and melted the snow. Ouch again! The good insulating properties of such things as wool, fur, and feathers are largely due to the air spaces they
contain. An example is acetic acid, C2H4O2, which, after water, is the main ingredient of vinegar. 380 PARTTWOCHEMISTRY occurs in a hydrogen-fluorine bond has a greater density of electrons and is slightly negative, while the
opposite side is slightly positive. The greater the resistance, the smaller the current. Astronauts inside an orbiting space vehicle have no weight, even though the force of gravity pulling them toward Earth is only slightly less than at ground level. The result is a wave of increased amplitude. Really! Except for air resistance, only the road provides a
horizontal force on the car. One million trillion of these are molecules of some poison, while 2 million trillion are water molecules. CHAPTER 9 M AG N E T I C I N D U C T I O N Tesla built generators that were much like those still in use, but guite a bit more complicated than the simple model we have
discussed. The fusion cycles repeat until the element iron is formed. What kind of ring do aromatic compounds contain? In the case of hurricanes and tornadoes, such predictions are lifesaving. Areas at high elevations were once much lower and covered by a shallow sea; they have now been uplifted. (net mv)before = (net mv)after (m * 10 m/s)before
= (2m * V) after By simple algebra, V = 5 m/s, Antinodes occur halfway between nodes, Might our universal need for water be our salvation or our demise? Artificial transmutation produces the hitherto unknown synthetic elements at the upper end of the periodic table. How much energy, in kilojoules, is released or absorbed from the reaction of 1
mole of nitrogen, N2, with 3 moles of molecular hydrogen, H2, to form 2 moles of ammonia, NH3? Studies of the center of our galaxy strongly suggest the presence of a black hole on some futuristic scientific mission. 471: Richard Megna/ Fundamental Photographs, NYC
474: Eric Schrader/Pearson Science 475: Toyota Motor Corporation Services 477: (top) Ballard Power Systems 477: (top) Ballard Power 
CHEMISTRY One way to assess the strength of an acid or base is to measure how much of it remains after it has been added to water. Telephone wires are longer and sag A Why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are longer and sag A why do telephone wires are lon
as Figure 16.10 shows. What additional force is needed to produce a one-way effect). DISCUSSIONQUESTIONS (unless the device also (unless the device is optically coated to produce a one-way effect). DISCUSSIONQUESTIONS (
E VA LUAT I O N ) 81. This is the principle of isostasy. (You'd know this if you placed your hand into a vacuum chamber and a cement truck rolled over it!) If you answered yes to this question, let this be a signal to be more careful when you think physics! F I G U R E 2 .11 Wingsuit fliers nicely mimic the physics that flying squirrels have always
enjoyed. So to find the number of Calories, divide your result by 1000. Each day the number of leaves doubles, until the pond is completely covered by leaves on the 30th day. VIDEO: von Jolly's Method of Measuring the Attraction Between Two Masses 1 kg * m1 (6.4 * 106 m)2 from which the mass of Earth is calculated to be m1 = 6 * 1024 kg.
Friction increases to 55 N, and again \boxtimes F = 0. The mechanism in a refrigerator is called a "heat pump." It moves heat "uphill" from a cooler to a warmer place. The Phases of the Moon Sunshine always illuminates half of the Moon's surface. VIDEO: Soap Works by Being Both Polar and Nonpolar 410 PA R T T W O CH E M I S T RY It is not just dipole.
induced FYI dipole attractions that keep carbon dioxide dissolved within water. Another thrust tips it from its vertical course. Explain why warm air rises and cools as it expands. What are the limits of nanotechnology? Because of their geologic history, these intraplate areas are zones of weakness. The physical properties of a substance can change
when conditions change, but that does not mean that a different substance is created. Energy is divided among more lamps, so the voltage drop across each lamp is less. Repeat the preceding eyeballing experiment, only this time use two one-dollar bills—one flat or unfolded, and the other folded along its middle lengthwise and again widthwise, so it
has 14 the area. The horizontal vector represents all the components of vibration horizontally. Water, with its high specific heat capacity, retains heat longer. According to this model, atoms tend to lose or gain electrons that result in an outermost occupied shell filled to capacity. Objects such as bags of rice and flour can survive this terminal speed,
so parachutes are seldom used. O O O Carbonate ion, 2µ O C O O Na Na C Na Sodium carbonate Na O C O Ca2 Mg2 Calcium or magnesium ions tend to be insoluble in water. To explain this lopsided distribution we need to
examine the very beginnings of Earth. Many of the smelly molecules of cooked fish are alkaline compounds. 778 PA R T F O U R ASTRONOMY (a) (b) FIGURE 28.9 (a) Everything is weightless inside a nonaccelerating spaceship far away from gravitational influences. Delicate molecules inside cells throughout our bodies that are zapped by gamma rays
suffer structural damage. The collision between continental plates has produced some of the most famous mountain ranges, one majestic example being the snow-capped 571 FIGURE 21.25 Earthquakes at a subduction zone get deeper and deeper in the direction of subduction. Neutralization A reaction between an acid and a base. The alteration is
greatest at the contact, which is the interface between the intrusive rock and the surrounding rock. Suppose instead that the mass is doubled. For greater distances, force is less. Einstein was led to this new theory of gravity by thinking about observers in accelerated motion. Rank the objects in order of increasing intrinsic motion as viewed from
Earth: (a) the Moon, (b) Venus, and (c) the North Star. What role does entropy play in chemical reactions? (d) dependent on whether it floats in salt or in fresh water. The specific heat capacity of steel is 450 I/kg # °C. However, these remains have been so changed over time that the forms and even the composition of the accumulated organisms are
beyond recognition. FIGURE 26.39 A meteor is produced when a meteoroid, usually about 80 km high, enters Earth's atmosphere. This quartz specimen shows its crystal form and conchoidal fracture. The resulting disk would take on the form of a spiral galaxy. 119. Likewise with a rainbow. Which exerts the force and which receives the force? The
force of attraction that holds ions or atoms together is the electric force. When a mineral is rubbed across an unglazed porcelain plate, it leaves behind Ruby a thin layer of powder—a streak. (b) Is it possible for water to be neutral but have a pH less than or greater than 7.0? 60. If so, what is the structure of the polymer formed, and what small
molecule is split off during the condensation? With polarization axes aligned, a pair of Polaroid filters will transmit all components of light along the axes. (d) the fundamental difference between light and sound. In this appendix, we won't treat the vector nature of angular momentum (or even of torque, which also is a vector). Coal-fired power plants
produce more atmospheric radiation than nuclear power plants. Therefore, quartz fractures. Except for a few fair-weather cumulus clouds, the skies become clear, and we have the calm after the storm. What is the average speed of a horse that gallops 100 m in 8 s? The outer planets are gaseous and much larger than the inner planets, which are
solid. Rather than being uniformly distributed throughout the cloud top) and negatively charged where the cloud is warmer (at the cloud bottom). When the crystal is exposed to water (as was first shown in Figure 16.4 and is shown again
here in Figure 16.11), an even greater number Sucrose of water molecules pull on the sucrose molecules molecules and the water molecules are tracts every other body with a force that, for two bodies, is directly proportional to the
product of their masses and inversely proportional to the square of the distance separating them: m1m2 F = G 2 d Lever A simple machine consisting of a rigid rod pivoted at a fixed point called the fulcrum. TUTORIAL: Parachuting and Newton's Second Law VIDEO: Friction V
Falling and Air Resistance 3 bricks, 1/3 as much acceleration is directly proportional to force. Some current models suggest that dark energy finds its source within the emptiness of spacetime. Knowing that S-waves travel only through solids, English seismoloCore gist Sir Harold Jeffreys confirmed 105° in 1926
that the core, or part of it, P-wave shadow must be liquid. (b) a condensation rate that exceeds the evaporation rate. When disorder in a system increase or decrease? Note that the vertical distance it falls A strobe-light photograph of two golf balls released simultaneously from a mechanism that allows one ball to drop freely
while the other is projected horizontally. (a) Scientists have yet to make the precise measurements. Where did these tiny bubbles come from? It does not depend on the loudness or the frequency of the sound; all sounds travel at the same speed in a given medium. The answer is (b): impure water can be purified by removing everything that isn't water
The more you know about science, the more passionate you feel toward your surroundings. Neutron An electrically neutral subatomic particle of the atomic nucleus. Evident is the rapid formation of new stars (blue) occurring as the two galaxies combined. For example, 6.02 X 1023! He 4.003 Na 22.990 Pb 207.2 F I G U R E 17. However, both O2 and
O3 are elemental forms of oxygen. Pressure The ratio of force to the area over which that force is distributed: force area Liquid pressure = weight density * depth Pressure air. When compressed from opposite sides, the wax
layers become shortened and deform into folds. (a) B = D, A = C. Because the water "bounced," the impulse exerted on the waterwheel was increased. Whereas electric charges produce electrical forces, regions called magnetic forces. Explain his "trick." 103. When you push a wheelbarrow, part of the force is directed
downward, which makes it harder to get over the step. Which has the greater density—an entire candy bar or half of one? White gold is an example h M n n n or more metallic elements. She may get really tired holding the barbell, but if it is not moved by the force she exerts, she does no work on
the barbell. www.masteringphysics.com xix xx TO THE INSTRUC TOR Another valuable media resource available to you is the Instructor Resource DVD for Conceptual Physical Science. If an atom has 43 electrons, 56 neutrons, and 43 protons, what is its approximate atomic mass? A similar effect can be seen by holding a charged balloon close to (but
not touching) the corner of an ice cube. As shown in Figure 15.7, the sodium atom loses one of its electrons to the chlorine atom, resulting in the formation of a positive sodium ion and a negative chloride ion. When Earth moves, the support unit attached to the ground also moves, but because of inertia, the mass at the end of the pendulum tends to
stay in place. 20.7 Igneous Rocks 18. LI F E AT TH E E X TR E M ES Some deserts, such as those on the plains of Spain, the Sahara in Africa, and the Gobi in central Asia, reach surface temperatures of 60°C (140°F). One of these five is a carbon atom, which is 15 * 100 = 20% carbon. What happens to a satellite close to Earth's surface if it is given a
speed exceeding 11.2 km/s? * Don't be discouraged if you cannot visualize four-dimensional spacetime, let alone the curving of spacetime. No, no, a thousand times no! No device can step up energy. As discussed in Section 17.3, chemical reactions slow down with decreasing temperature. He developed an early interest in motion and was soon at
odds with others around him, who held to Aristotelian ideas on falling bodies. The freezing, then thawing, of three common refrigerator items—ice, butter, and cheese—will help solidify your understanding of partial melting. Interestingly, about 1% of the carbon we eat is the carbon-13 isotope containing seven neutrons per nucleus. However, staring
at the Sun when it is high in the sky is harmful whether or not an eclipse occurs. (It does the same when flying right side up, but then, because the wings are designed for rightside-up flight, the tilt of the fuselage may not need to be as great.) 109. 8. The two necessary quantities are magnitude and direction. (The specific heat capacity of iron is 0.11
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cal/g # °C.) 55. If the same amount of paint travels in straight lines for 2 m, it spreads to a patch twice as tall and 
energy. A communication satellite with a 24-h period hovers over a fixed point on Earth. Blood is a suspension composed of finely dispersed blood cells in water. Rank the following from greatest to least: (a) momentum and (b) the impulses needed to stop the balls. (b) Nothing; the HCl gas would merely bubble out of solution. What are some of the
obstacles people face when trying to recycle materials? As the sizes of the cloud droplets grow, they fall to Earth and we have rain. When taking a shower, you Evaporation may have noticed that you feel warmer in the moist shower region than outside the shower. With his inclined-plane experiments? What happens to your weight reading as you
jump? Interestingly, the friction supplied by the brakes is the same whether the car moves slowly or quickly. The distance from the hermit to the mountain = speed of sound * time = (about the 340 m/s * 3600 s/h * 4 h = 4.9 * 106 m = 4900 km S-11 distance from New York to San Francisco)! (Very far and, due to the inversesquare law, also very
weak!) 57. Wouldn't it be wonderful if we could get energy for nothing, to possess a machine that gives out more energy than is put into it? So the greenhouse effect actually plays a bigger role in global warming than it does in the warming of florist greenhouses. These forces do cancel each other. (b) In accord with the work-energy theorem, that gives out more energy than is put into it? So the greenhouse effect actually plays a bigger role in global warming than it does in the warming of florist greenhouse effect actually plays a bigger role in global warming than it does in the warming that the warming that the warming that it does in the warming that the warming
force component multiplied by the distance the ball travels is equal to the change in the ball's KE. (a) Piston Piston Isooctane (b) The gasoline obtained from the fracture zone that forms a transform plate boundary is called a transform fault.
CHECKPOINT What do the processes of thermonuclear fusion and gravitational contraction have to do with the physical size of a star? If one student scored higher, it would raise this average to 81%. You can make rain in your kitchen. The changing electric field in turn induces a changing magnetic field. So a north wind, which blows north to south in
the Northern Hemisphere, creates a surface current that S-26 O D D - N U M B E R E D S O LU T I O N S moves to the west-southwest. (c) condensation nuclei. Rather, he just postulated it to account for the apparent stability of the universe. Therefore, there's more pressure. (a) Carbon dioxide escapes when a soda can is opened. (c) What is its wave
speed? FIGURE 4.11 The inhabitants in this laboratory and docking facility continually experience weightlessness. (a) exothermic, because ultraviolet light is emitted during its formation (b) endothermic, because ultraviolet light is emitted during its formation (d)
endothermic, because ultraviolet light is absorbed during its formation REVIEW 18 C H A P T E R 1 8 Two Classes of Chemical Reactions D uring a chemical reaction, the 18. Front The contact zone between two different air masses. Can you now see that the transform fault is indeed a plate boundary? Currently, about 20% of electric energy in the
United States is generated by nuclear fission reactors (whereas most electric power is nuclear in some other countries—about 75% in France). ore than 4000 known minerals exist on Earth, and new ones are discovered every year. Most materials we encounter are mixtures: mixtures of elements, mixtures of compounds, or mixtures of elements and
compounds. It is impossible to imagine the heights to which may be carried, in a thousand years, the power of man over matter. 48 PARTONEPHYSICSFIGURE2.19 Action and reaction forces. If we searched the far reaches of the universe for eons and found no life, then that would not prove that it doesn't exist "around the next corner." A
hypothesis that is capable of being proven right but not capable of being proven wrong is not a scientific hypothesis. Furthermore, utility companies can sell electricity at cheaper rates at night because their massive generators are underutilized at that time. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E
R M S (KNOWLEDGE) Ellipse The oval path followed by a satellite. When air resistance is small enough to neglect, as it is for a heavy object without great speed, the trajectory is parabolic. Whoa! Why the difference? (a) Voltage flows in a circuit. Greek science was reintroduced to Europe by Islamic influences that penetrated into Spain during the
10th, 11th, and 12th centuries. Start by mixing sugar and water in a 2:1 ratio by volume. A beam of high-energy protons emerges from a cyclotron. After the thunderstorm dissipates, it leaves behind the cirrus anvil as a reminder of its once-mighty presence. According to a French riddle, a lily pond starts with a single leaf. A typical soap molecule has
LEARNING OBJECTIVE Describe the mechanism by which soaps and detergents clean and how this mechanism is foiled by hard water. Molecules Can Form Ions So we see that atoms form ions by losing or gaining electrons. On a sensitive balance, weigh an empty, flat, thin plastic bag. Assuming that both balls were the same size yet one was much
heavier than the other, which ball actually struck the ground first? Just as ice melts at the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral's melting point is the same temperature at which water freezes, a mineral water freezes, a mineral water freezes, a mineral water freezes at the same temperature at which water freezes at the same temperature at the same temper
temperatures. The term planet is derived from the Greek for "wandering star." F I G U R E 2 6 .1 This illustration shows the order and relative sizes of planets. The higher the order and relative sizes of planets. The higher the order and relative sizes of planets.
particles in order of increasing mass: (a) neutron, (b) proton, (c) electrons? Just after it reaches terminal velocity? Does wavelength change? For a satellite close to Earth, the period (the time for a complete orbit about Earth) is about 90 min. Head south to Antarctica! The asteroid belt is a
collection of rocks located between the orbits of Mars and Jupiter. The solubility of carbon dioxide in water decreases with increasing temperature. Why is it sometimes difficult to decide whether an observed change is physical or chemical? 3 Reaction Rates 17. A semipermeable membrane contains submicroscopic pores that allow the passage of
water molecules but not of larger solute ions or solute molecules. As shown in Figure 18.28, experimental fuel-cell buses are already operating in several cities, such as Vancouver, British Columbia, and Chicago, Illinois. Suppose you point to a wall with your arm extended. Earth's magnetic field deflects many of the incoming cosmic rays, reducing the
intensity of rays striking Earth's surface. The molar mass of molecular oxygen, O2 (formula mass = 31.998 amu), is 31.998 g/mole. Distinguish between speed and velocity. Which of the boxes above best represents a suspension? The slowing of light in transparent materials has to do with (a) the time for absorption and re-emission of light. (a) Both
consist of atoms of different elements. If you shake the free end up and down, you produce vibrations that are at right angles to the direction of wave travel. Self-Guided Tutorial Activities These activities T
to your favorite uncle and bring him up to speed on your progress with physics. The greater the frequency of shaking, the greater the number of nodes. This elongation of light waves due to the expansion of space is called the cosmological redshift. There is usually a layer of salt remaining on your skin from perspiration, which, when wet, lowers your
skin resistance to a few hundred ohms or less. ur solar system is the collection of objects gravitationally bound to the Sun. When you touch a piece of ice, however, thermal energy passes out of your hand and into the colder ice. Both Europe and Canada receive about the same amount of sunlight per square kilometer. These materials are transparent
to light. At Earth's surface, subduction zones are marked by deep ocean trenches that run parallel to the edges of convergent boundaries. (a) The first compression meets the fork and gives it a tiny and momentary push; (b) the fork bends and then (c) returns to its initial position just at the time a rarefaction arrives and (d) overshoots in the opposite
direction. Paper clip Lemon Copper wire P L U G A N D C H U G (F O R M U L A FA M I L I A R I Z AT I O N) Coulomb's law: F g k q1q2 d2 35. Divergent boundaries—where plates move away from each other 2. Clouds with Vertical Development Cumulus clouds are denser FYI than the surrounding air. + Only protons repel one another by the
electric force. FYI 3. Hydrogen and oxygen gas are combined at electrodes and electric current is produced, along with water. What are they if the polonium emits an alpha particle? CHAPTER 5 98. Energy The property of a system that enables it to do work. Rainwater physically erodes the rock by washing away its weakened outer layers, leaving
rounded boulders behind. Provide an explanation. We express the temperature of matter by a number that corresponds to the degree of hotness on some chosen scale. If an object moves along a curved path, then it must be (a) accelerating. ne of the first key discoveries in support of continental drift came about through studies of Earth's magnetic
field. Measuring this shift allows us to calculate their speed. Cells absorb and try to use the H2S as though it were O2, but without the oxidative powers of O2, the cell's machinery simply shuts down. Dark matter Invisible matter that has made its presence known so far only through its gravitational effects. (a) Muscovite, a mineral of the mica group,
has perfect cleavage in one direction. Interpret this observation in terms of inertia. 26.4 The Outer Planets are gaseous, but their interiors are mostly liquid. When a bird lets go of a branch and drops to the ground below, why doesn't the moving Earth sweep away from the falling bird? What really exists are a series
of tiny dots (pixels) that change color in a coordinated way to produce images. Why isn't the solute carried over into the mug? Each ant may therefore think that it is at the center of the expansion. The same result holds true for a beam of light (Figure 28.12). He had no proof for the existence of such a phenomenon. LEARNING OBJECTIVE Distinguish
between electric potential energy and electric potential. The gold and platinum we wear for jewelry here on Earth, as well as the bulk of Earth itself, are dust from supernovae that exploded many years before our solar system came to be. These ideas conflicted with the popular view that Earth was the center of the universe. If the contrails are still
present and have grown thicker, the humidity of the atmosphere is high enough for cloud formation. Tornadoes A revolving object, such as a whirling ball on a string, speeds up when pulled toward its axis of revolution, thus conserving its angular momentum. Ultraviolet radiation is also damaging to the eyes. Now we see how molecules mix together.
A geyser and a coffee percolator work on the same principle. What did Aristotle believe about the relative speeds of fall for heavy and light objects? Many people feel that it is a sign of weakness to change their minds. If we immerse a sealed 1-L container halfway into the water, it displaces half a liter of water and is buoyed up by the weight of half a
liter of water. Is it correct to say that a transformer boosts electric energy? Any atom with a net electric charge is an ion. You can see the road ahead of your car at night, for instance, because of diffuse reflection by the rough road surface. Energetic vibrations produced by incident light on the atoms of these materials are turned into random kinetic
energy—into thermal energy. Fusion of elements with atomic numbers greater than those of iron consumes energy rather than liberating energy. Isn't this a contradiction? They play an essential role in the global transfer of thermal energy from the equator to the poles. A weak acid dissolved in water generates only a few ions, as indicated in Figure
18.8. The presence of fewer ions means there can be only a small electric current. Water is a poor heat conductor, so if the body of water is deep and in a region of long winters and short summers, the water at the bottom is likely to remain a constant 4°C year round. Once formed, these condensation polymers cannot be remelted or reshaped, which
makes them hard-set, or thermoset, polymers. CHECKPOINT When was the bottle half-full? Basic pH 14 Neutral 7 Acidic 0 Basic pH 14 OH Half-full? Basic pH 14 OH Half-full? Basic pH 14 Neutral 7 Acidic 0 Basic pH 14 Neutral 7 Acidic 0 Basic pH 14 OH Half-full? Basic pH 14 OH Half-full?
formula for ammonia? Thus newer and more accurate (and more complicated) conceptual models of the atom have since been introduced. What is the average speed of the ball during this 1-s interval? Others reveal interesting applications of concepts.
Hey Liam, like everyone, I'm made of atoms, which are so small and numerous that I inhale billions of trillions with each breath. The nucleus attracts the electrons and holds them in orbit, similar to the way the Sun holds them in orbit, similar to the way the Sun holds the planets in orbit.
nature and are often considered the most fundamental of physical laws. As silver tarnishes, is it oxidized or reduced? If a lot remains, the acid or base is weak. The Asteroid Belt and Meteors Meteorites fall all over our planet, but the easiest place to find them is on the icy white surfaces found in polar regions. The new rock, which now has parallel
flakes, or plates, of mica, is said to be foliated. They hold the ball together, but they play no role in accelerating the ball. The width of the altered zone may range from a few centimeters to several hundred meters. (c) Laser light is an exception to this rule. Except for volume, the answer to all the questions is yes. But just because we can name
something doesn't mean we understand it. Hewitt 615: Sasha Buzko/Shutterstock 620: Adam Burton/Alamy 621: Bryan Brazil/Shutterstock 628: Lynette Cook/Photo Researchers, Inc. 7 Inter ference 10. Pure PVC, for example, is a tough material great for making pipes. Bernoulli's principle explains why trucks passing closely on the highway are drawn
to each other, and why passing ships run the risk of a sideways collision. Fair skin may develop a tan upon exposure to ultraviolet, which may afford some protection against further exposure. As we shall see, igneous rocks are formed from magma, and certain sedimentary rocks are formed from water solutions. Explain what happens to the alcohol
molecules deposited on the tabletop. F I G U R E 1 7.1 0 INTERACTIVE FIGURE Reactants . We can also double the density of a fixed amount of air by compressing it to half its volume. 5.1 Density 2. But it has more electrons to pull, a balancing act that barely changes the atom's size. What catalyst is effective in the destruction of atmospheric ozone,
O3? Energy production from fossil fuels has benefited society in countless ways. If you drop a hot rock into a pail of water, the temperatures of the rock and the water change until both are equal. Why do you lurch forward in a bus that suddenly slows? 302 PA R T T W O CH E M I S T RY Please put to rest any fear you may have about needing to
memorize the periodic table, or even parts of it—better to focus on the many great concepts behind its organization. We need look no further than our own bodies to find evidence of the feasibility and power of nanotechnology. How many molecules of water are there in 18 g of water? Carefully place one drop of solvent on top of the dot, and watch the
ink spread radially with the solvent. Which set provides the most "radioactivity" after a toss? As we'll discuss in Chapter 18, carbon dioxide reacts with water to form carbonic acid, which is much more soluble in water. One quantum (photon) of light energy, each packet called a quantum, as represented in Figure 12.24. What happens to starlight as it
passes close to the Sun? Fluctuations in the Sun's magnetic field as well as changes in the strength of Earth's atmosphere, which in turn produce fluctua- every 5730 years, with the result that today the skeleton contains only
tions in the production of C-14. Solid Liquid Gas Energy is released when change of phase is in this direction. The silver atoms, Ag, are the reducing agents because they cause the tin ion to gain electrons. Convectional lifting, orographic lifting, and frontal lifting. If they were, then medicine would not be successful at keeping them alive. 1 Chemistry:
The Central Science 14. When this occurs, we have frontal lifting. (b) The corrosive properties are embedded in the noncorrosive salt. An observer at A, on the other hand, measures a lower frequency because of the longer time between wave-crest arrivals. When we place it in the water, it settles into the water, displacing a greater volume of water
Earth's center). What does the phenomenon of polarization have to do with this? It cannot have a charge equal to the charge of 1.5 or 1000.5 electrons, for example. Unsaturated fats, such as vegetable oils, are liquid at room temperature. Before crystallization, the mass percentage of silica in the magma is 500 kg silica * 100% = 50% 1000 kg magma
The chemical formula of olivine is MgFeSiO4. There's gotta be a reason—mechanical rules of some kind. The silicates are subdivided into two groups: those that do not (nonferromagnesian). Dividing each term by V gives Req R1 R2 R3 Rn 1 1 1 1 = + + + p + . Also included are more
than a dozen smaller elliptical galaxies, including the Leo I galaxy shown in Figure 27.24, and a few irregular galaxies, such as the Large Magellanic Cloud. And we know water pressure acts sideways when we see water spurting sideways from a leak in an upright can. An atom is the smallest particle of an element that has all the chemical properties
of the element. The two primary methods of removing salts from seawater or brackish water are distillation and reverse osmosis. Ignore any friction between the cart and the tracks. For the altitudes of most Earth's surface. "Magnetic walls" of sufficient
strength provide a kind of magnetic straitjacket for hot gases called plasmas. The square on the bottom absorbs all the colors illuminating it. This simple relationship, which has been confirmed by numerous measurements over many decades, is known as Hubble's law: v = H * d where v is the velocity of a galaxy as deduced from its
cosmological redshift, H is a constant known as Hubble's constant, and d is the distance of the galaxy from Earth. Heteroatoms make a difference in the physical and chemical properties of an organic molecule because (a) they add extra mass to the hydrocarbon structure. The closer the celestial object, the faster the appearance of the intrinsic
motion. This property of objects to resist change in motion is called inertia. It occurs whenever successive impulses are applied to a vibrating object in rhythm with its natural frequency. The first copy of his famous exposition reached him on the day he died—May 24, 1543. The constant of proportionality is g, the acceleration due to gravity. Under
most conditions, the cold front moves eastward faster than the warm front. If 80% of all igneous rocks are formed from basaltic magma, why do we see so much granite? As was explained in Chapter 12, the electromagnetic force is responsible for the repulsion between electrons. Like the oil in Fusion reactions of hydrogen isothe storage depot, any
amount of fusion fuel can be stored safely until ignited. Convection involves bulk motion of a fluid (currents) rather than interactions at the molecular level. Newton's universal law of gravity tells us that F = G(m1m2/d\ 2). Drinking through a straw is slightly more difficult on top of a high mountain. In a helium nucleus, which has two protons, each
proton feels the repulsive effect of only one other proton. Boiling and freezing can occur at the same time when water (a) Osmosis Salt water (b) Equilibrium Net flow of water molecules (c) Reverse osmosis Net flow of water molecules C H A P T E R 16 Semipermeable membrane Desalinated
water MIX TURES 417 Pressurized salt water Concentrated salt solution FIGURE 16.34 succeeded in building durable reverse osmosis units, shown in Figure 16.34, that can be networked together to generate fresh water from seawater at rates of millions of gallons per day. One Earth rotation actually takes 24 h 3 min 57 s. There are only two inner-
shell electrons (2 - ) that shield the outer-shell electrons from this positive charge. If you push horizontally on a carton that contains your new kitchen appliance and it slides across the floor, slightly gaining speed, how does the friction acting on the carton compare with your push? Wow! Cosmic Background Radiation In addition to the expansion of
the universe, a second line of evidence supporting the Big Bang theory is cosmic background radiation. CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E 2. Cooking and chemistry are similar in that both require measuring ingredients. Explain, using molecular terms. FIGURE 26.34 A lunar eclipse occurs when Earth is directly
between the Moon and the Sun and Earth's shadow is cast on the Moon. Magnetic force (1) Between magnets, it is the attraction of unlike magnetic poles for each other and the repulsion between like magnetic poles. Some instead reacted with volcano-generated sulfur dioxide to form sulfuric acid, which now laces the upper levels of the Venusian
atmosphere. Absolute zero isn't the coldest you can get. Supercritical water is very corrosive. (b) By how much does its speed increase each second while it is descending? MOHS SC ALE OF HARDNESS Hardness 1 2 3 4 5 6 7 8 9 10 Object of Similar Hardness Fingernail (2.5) Copper wire or coin (3.5) Steel knife blade, glass (5.5) Unglazed porcelain
tile (6.5) Hardness Hardness Hardness does not refer to how easily a mineral breaks, but rather to its resistance to scratching. Polar covalent H F F F Hydrogen fluoride Molecular fluorine Na F 15.7 Molecular Polarity EXPLAIN THIS Which is heavier: carbon dioxide or water? CHAPTER 7 49. Fortunately for Europeans, the Atlantic Ocean
current known as the Gulf Stream carries warm water northeast from the Caribbean Sea, retaining much of its thermal energy long enough to reach the North Atlantic Ocean off the coast of Europe. If we let d stand for the distance traveled, a for the acceleration, and t for the time, the rule may be written, in shorthand notation, d = 12 at 2 This
relationship was first deduced by Galileo. What is the relationship between a supergiant star and a black hole? A substance whose ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as its ability to behave as an acid is about the same as a base is said to be amphoterial acid is about the same as a base is said to be amphoterial acid is about the same acid is acid in the same acid is acid in the same acid is acid in the sam
According to the definition of d 3 * 10 m speed in Chapter 2, v = = 30 m/s, because 30 m of train t 1s passes you in 1 s. In both cases, a greater pressure below pushes the roof or the wing into a region of lesser pressure above. The important distinction is that elements are made of atoms and not the other way around. A weight suspended from a
spring is seen to bob up and down over a distance of 20 cm twice each second. Minerals differ from one another in their combination of elements and/or in the internal arrangement of their constituent atoms. A 24-karat gold ring is as pure as can be. n Section 12.4 you learned about the properties of metals. Unsaturated fatty acids, such as
C12H22O2, react with hydrogen gas, H2, to form saturated fatty acids, such as C12H24O2. We will explore how there are many different types of galaxies. It is conceptual because it deals not in numbers, but in concepts directly. Like so much in the complex real world, this is but one physics principle
that applies. The shallow seas are now gone, so the carbonate rocks are exposed. In shorthand notation, P1V1 = P2V2 where P1 and V1 represent the original pressure and volume, respectively, and P2 and V2 the second pressure and volume.
the Crab Nebula (Figure 27.17). The falling rain drags some of the cool air along with it, creating a downdraft—the chilled air is colder and denser than the air chamber is tripled. However, 1 C is a fairly respectable amount of charge. If we can detect a dangerous space
fragment early enough, we can take actions to alter its orbital path sufficiently to avoid impending disaster. The total charge that an automobile battery can supply without being recharged is given in ampere-hours. THINKANDRANKEUP." The sound echoes off the nearest
mountain and returns 8 h later. 542 PARTHREEEARTHSCIENCE Living things, especially microorganisms, are unimaginably abundant in rivers, lakes, and oceans. Nearly everybody has witnessed a lunar eclipse, but relatively few people have seen a solar eclipse. What happens to its acceleration? Bakelite was synthesized in the early
1900s, and it was the first widely used polymer. (b) ships of different weights float in each. The molten outer core flows at the rate of several kilometers per year. (d) wetness. Constructive interference results from crest-to-trough cancellation. For a fault resulting from compressional
forces, the hanging wall is pushed upward along the fault plane relative to the footwall, as Figure 21.33 shows. Ouch! Instead, you bend your knees when your feet make contact with the ground. The support force on the jug is W. A metal box partially exhausted of air with a slightly flexible lid bends in or out with changes in atmospheric pressure. Red
Green Blue Frequency F I G U R E 11. What if there was a symmetry to cosmic background radiation such that the pattern of temperature fluctuations in one direction was exactly the same pattern seen in the exact opposite direction? A number of flowers, for example, owe their pleasant odor to the presence of simple aldehydes. C H A P T E R 14 E L
decomposition. How frequently do they collide with our planet, and why does a comet's tail always point away from the Sun? Your partner isn't distinguishing between the internal pressure in a fast-moving fluid and the external pressure that fluid can exert on something in its way. Unless it collides with another body, it will wander indefinitely
through interstellar space. In simplest terms, a force is a push or a pull. (a) How far would the car travel if it moved at this rate for 4 h? The fluorine side of the molecule is therefore slightly negative, and the hydrogen side is slightly positive. How many structural isomers are there for hydrocarbons that have the molecular formula C4H10? d, c, a, b
(b) Explain, however, why the force due to gravity on the pendulum at nearly every point does work on the pendulum? The voltage step-up is (12,000 \text{ V})/(120 \text{ V}) = 100, so there should be 100 times as many turns on the pendulum? The voltage step-up is (12,000 \text{ V})/(120 \text{ V}) = 100, so there should be 100 times as many turns on the pendulum? The voltage step-up is (12,000 \text{ V})/(120 \text{ V}) = 100, so there should be 100 times as many turns on the pendulum? The voltage step-up is (12,000 \text{ V})/(120 \text{ V}) = 100, so there should be 100 times as many turns on the pendulum? The voltage step-up is (12,000 \text{ V})/(120 \text{ V}) = 100, so there should be 100 times as many turns on the pendulum? The voltage step-up is (12,000 \text{ V})/(120 \text{ V}) = 100, so there should be 100 times as many turns on the pendulum?
Al2O3? This chance discovery led to the invention of the chamical cell and the battery. (Water with dissolved sugar is denser than pure water.) Also, the weight of the can is less than the buoyant force that would act on it if it were totally submerged. Rapidly increasing wind speed and changing wind direction with height cause the updraft within the
storm to rotate. What are the chemical formulas for the following structures? Phenol was the first purposefully used antibacterial solution, or antiseptic. Is it possible to supplement our diet by simply eating rocks? 7.2 Convection 5. This greatly reduces the resistance in the circuit and is called a Current short circuit. The data in Table 26.1 also show
the division of the planets into two groups with similar properties. A surface therefore may be polished for radiation of long wavelengths but rough for light of short wavelengths. A physical property is the description of the physical attributes of a substance, such as color, hardness, density, texture, and phase. Suspend an open-topped container of
water in a pan of boiling water, with its top above the surface of the boiling water. Through his wartime scientific surveying, Hess constructed a detailed profile F I G U R E 2 1 .1 2 Wegener likened the fossil and rock matches to finding two pieces of torn newspaper with matching contours and lines of type. As a result, graphite and diamond show
important to see that the impurities are in the water and not part of the water, which means that it is possible to remove them by a variety of physical means, such as filtration or distillation. This idea is not so far-fetched. (c) 5 N east. (b) Bismuth, Bi, loses its iridescence upon melting. These loose thony dollar coin—so that the new coin could sub-
electrons form a kind of "electronic fluid," which flows through the lattice of positively charged ions. G-4 G L O S S A RY Electromagnetic induction The induction of voltage when a magnetic field changes with time. Many objects or systems may be described just as well by a physical model as by a conceptual model. (c) found in the common mineral
quartz. This molecular vibration increases the thermal energy and temperature of the material, which is why infrared waves are often called heat waves. Learning about nature's rules is relevant with a capital R! We will see in this book that science is much more than a body of knowledge. Thunder is often heard seconds after a flash of lightning is
seen. MAGNETIC THERAPY* Back in the 18th century, a celebrated "magnetizer" from Vienna, Franz Mesmer, brought his magnets to Paris and established himself as a healer in Parisian society. Starburst galaxy in which stars are forming at an unusually fast rate. When one of these ancient jets faces our direction, the result is an unusually
brilliant display of energy we call a blazar. When the volume of storm water runoff exceeds the stream channel's capacity, the result is flooding. Intensely compressed and metamorphosed rock defines the zone where continental plates meet. What we do know is that energy usage is related to population size. Archimedes' insight preceded Newton's
law of motion, from which Archimedes' principle can be derived, by almost 2000 years. An uncle sensed the scholarly potential in young Isaac and prompted him to study at the University of Cambridge, which he did for five years, graduating without particular distinction. Who ends up being slightly positive? The acceleration is zero, as evidenced by
the constant velocity. The radiation emitted by the object in question provides the reading. We hear weather forecasters talk about short-, medium-, and long-range forecasting. The amount of gravitational potential energy possessed by an elevated object is equal to the work done against gravity in lifting it. Does this violate conservation of
momentum? When the Sun passes between the Moon and Earth, we have (a) a lunar eclipse. If it has KE, then with respect to the frame of reference in which its KE is measured, it also has momentum. Small CHAP TER 25 D R I V I N G F O R CE S O F W E AT H E R 691 FIGURE 25.8 The four cloud groups. A rechargeable battery can be made to
operate again, but only after the energy flow is interrupted so that the reactants can be replenished. So measuring the speeds of Pen Support unit seismic waves provides clues about Rotating drum Earth's composition. C H A P T E R 12 REVIEW 317 Try looking at different brands of fluorescent bulbs. Suppose Star A is four times as luminous as Star
B. See also Plate tectonics paleomagnetism and, 563 seafloor spreading and, 564-566 Continental margin, 651 Convectional lifting, 694 Convergent plate boundaries, 569-572 Cooling. The rate of cooling influences crystal size. (b) energy. Instead of
measuring the angles of Angle of Angle of Angle of Angle of Inc ay ide incidence r reflection incident and reflected rays from the reflecting surface. This may sound counterintuitive, because if they have more mass, they have more fuel to burn longer,
right? If particles are angular, then a short travel time is indicated. th 's or b it Ea The comet warms as it gets closer to the Sun and initially develops a coma, which is a halo of gases surrounding the comet mucleus. In this case the acceleration is g = 9.8 m/s2. When you blow across the top surface, the paper rises. Show that if you could somehow that you could somehow tha
travel there at jet-plane speed, 2000 km/h, the trip would take about 4.3 million years. The chlorine, however, reacts with organic compounds within the effluent to form chlorinated hydrocarbons, many of which are known carcinogens (cancer-causing agents). Within the context of this chapter, try contemplating the sheer size of the universe. (The
pistons are simply "plugs" that can slide freely but snugly inside the tube.) The pressure that the left piston exerts against the water exerts against the right piston. A 2 percent growth rate for world population means the population of the world doubles every 35 years [70%/(2%/year) = 35 years]. The
amplitude is 30 cm, half of the crest-to-trough height distance. Atoms are indeed mostly empty space. At this level humidity cannot increase because the air is saturated. (c) Low-silica minerals (rocks) are the first to form. Water changes to the gaseous phase by the process of evaporation. That's the speed at which the electric field in the wire is
established. A beta particle is an electron ejected from a nucleus. This is because its deceleration by gravity while going up is the same as its acceleration to m/s by gravity while coming down. According to Einstein's theory of special relativity, at 60% of the speed of light, gold's innermost electrons experience only 52 seconds for each one of
our minutes. During O D D - N U M B E R E D S O LU T I O N S the height of glaciation, as much as one-third of Earth's surface was covered by ice. Two carbon atoms connected by a single bond can rotate relative to each other. This net flow of water across a semipermeable membrane into a more concentrated solution is called osmosis. Neglecting
air resistance, the object will have a constant acceleration of about 10 meters per second (actually more like 9.8 m/s2, but we want to make the numbers easier to follow). Think of a compass needle that lines up with a magnetic field. Plans for trains that run on solar power collected on railroad-track ties are presently at the drawing-board
stage (see ). For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Concentration A quantitative measure of the amount of solute dissolved in a solution. (b) An impression or cast is made by an organism (or part of an organism) that was buried quickly before it could decompose. Our fate
likely lies between these extremes. At the microscopic level, physical structure is so fine that it can be seen only with a microscope. How many spiral galaxies are in the Local Group? LEARNING OBJECTIVE Describe how the strength of an acid or base affects the number of ions in solution. We would also expect more human-made calories of heat to
be absorbed by Earth's ecosystem than have been absorbed in the entire past! At the previous 7 percent annual growth rate in energy production, all this would occur in one doubling time of a single decade. 25.6 The Weather—The Number One Topic of Conversation EXPLAIN THIS M LEARNING OBJECTIVE List the information needed to predict the
nonpolar grime molecules via induced dipole-induced dipole-induced dipole-induced dipole attractions, as Figure 16.23 illustrates. Countries with less money (for example, Haiti) do not necessarily have the resources to prepare and are dependent on help from other countries. Most males are more muscular and slightly denser than females. Ultimately, lithospheric plates move in
response to convection in Earth's interior. The two moons of Mars, for example, are thought to be former asteroids. Batteries now deliver power to devices implanted in the human body. Does this mean that oxygen, O2, and water, H2O, have similar properties? FIGURE 21.35 1. When radiation encounters the intricately structured molecules in the
watery, ion-rich brine that makes up our cells, the answer involves a bit of geometry. So air resistance depends on speed and the frontal area encountered by the air. An observer in the umbra part of the shadow experiences darkness during the day—a total eclipse, totality. Desalinization of seawater
is another. It may find that by walking straight it also walks in circles—it comes back to its starting point. But momentum would also be conserved if one ball popped out at twice the waves passing by that point. 5.5 Pressure in a Gas 18. C
HAPTER1668. How many atoms of each element are there in one molecule of H3PO4? A satellite in Earth orbit is mainly above Earth's (a) atmosphere. Likewise, any machine that multiplies distance, such as your forearm and elbow, does so at the expense of force. Midocean ridge Lithosphere l -pul Slab Trench Asth enos Temperature and
pressure increase 0 70 pher e Mantle km Outer core Convection cells Convection cells Convection cells Convection cells Convection induces magma generation and the formation of volcanoes on the seafloor. Suspend twice as much flour from the scale and the reading will be 18 N. This produces a warm climate. 308 PART WO CHEMIST RYFIGURE
12.21 White light is separated into its color components by (a) a prism and (b) a diffraction grating. This is a must-do activity! 43. Additive primary colors The three colors—red, green, and blue—that, when mixed in certain proportions, can produce any color in the spectrum. Such regulations as the international ban on ozonedestroying
chlorofluorocarbons have been enacted to protect the environment. (b) opaque to the same light that is reflected from an interior surface. How do the speed of a wave source and the speed of the waves themselves compare when a wave barrier is being produced? When the rising air reaches an altitude at which the air density is the same, it no longer
rises. (Assume that 1 light-year equals 63,000 AU.) 40. In each molecule, which atom carries the greater positive charge: H i Cl, Br i F, C, O, Br i Br? Why do the stars appear to turn on an imaginary north- south axis once every 24 hours? Antarctica is covered by glaciers and large ice sheets. Boiling A rapid state of evaporation that takes place within
the liquid as well as at its surface. Which color of light comes from a greater energy transition: red or blue? The resulting atom belongs to an element one place forward in the periodic table. 8 Corrosion and Combustion atoms of the reactants change partners to form new materials we call products. Only the most elementary "math" is involved with
Plug and Chugs. When the paradise tree snake (Chrysopelea paradisi) jumps from a tree branch, it doubles its width by flattening itself. Figure 15.12. What is the difference between a soap and a detergent? Both involve the burning of sulfur within the tip of the match. This side group interferes with the close packing that could otherwise occur
among the molecules. How can you use a garden hose filled with water to determine equal elevations for distant points? Lillian rides her bicycle along a straight road at average velocity v. There have been cases of victims of lightning who did not breathe without assistance for several hours, but who were eventually revived and who completely
regained good health. hat happens when table sugar, known chemically as sucrose, is stirred into water? At night, the process reverses because the shore cools off more quickly than the water, and there are three reasons. Calculate your estimated annual dose of
radiation using the EPA's radiation dose calculator available at .epa.gov/radiation/understand/calculate.html. Ideally, of course, you should distance yourself as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weighs four times as much as possible from all of the rocks. A railroad diesel engine weight from the rocks are the rocks as the rocks are the rocks as the rocks are the 
another. s briefly described in Chapter 12, the terms element and atom are often used in a similar context. A strong magnet attracts a paper clip to itself with a certain force. Only substances with very low boiling points, such as methane (bp -160°C), are able to make it to the top. After studying balls rolling on planes inclined at various angles, he
concluded that an object, once moving, continues to move without the application of forces. Each atom of any group 17 element has room for one additional electron in its valence shell and therefore tends to form the 1- ion. The same thing happens when an aircraft travels at the speed of sound. Machine A device, such as a lever or pulley, that
increases (or decreases) a force or simply changes the direction of a force. Refrigerator magnets have narrow strips of alternating north and south poles. Fortunately, the electrical force is not great enough to make her arms stand out! 8.4 Electric Potential EXPLAIN THIS Why aren't you harmed when you touch a 5000-V party balloon? You would be
"ripped" of the opportunity to experience what it would be like inside the event horizon. When air resistance is a factor, the snowball returns with less speed (air resistance never increases speed!). Atmospheric pressure on the drink then pushes the liquid up into the reduced-pressure region. What happens to the polarity of oxygen atoms as they
transform from molecular oxygen, O2, into water molecules, H2O? A discussion of this raises some eyebrows: Why is the buoyant force on a submerged submarine appreciably greater than the buoyant force on it while it is floating? The difference is exceedingly small, but the results of the experiment are reproducible and in strict accordance with
Einstein's prediction (Figure 28.16). What is the function of the third prong on the plug of an electrical appliance? Rubies are red because of minor amounts of iron and titanium ions. The overall result is a white cloud. Handling electrical devices while taking a bath is a definite no-
sustained use of fuel? CHECKPOINT List these bonds in order of increasing polarity: P i F, S i F, Ga i F, Ge i F (F, fluorine, atomic number 31; Ge, germanium, atomic number 32). CO2 CO2 Carbon dioxide is absorbed. youngest. Cleavage The tendency of a
mineral to break along planes of weakness. An astronaut lands on a planet that has the same mass as Earth but twice the diameter. Supernova The explosion of a massive star caused by gravitational collapse with the emission of enormous quantities of matter and radiation. Light travels faster through the thinner hot air near the surface than through
the denser cool air above. Vector An arrow that represents the magnitude and direction of a quantity. 107 8 km/s FIGURE 4.31 CHECKPOINT 1. Note in the photograph shown above that represents the magnitude and direction of a quantity. 107 8 km/s FIGURE 4.31 CHECKPOINT 1. Note in the photograph shown above that represents the magnitude and direction of a quantity.
of 20 m is given, but the time is not stated. Like electrons, protons have a "spin" property, so they align with a magnetic field. If a car travels with an average speed of 60 km/h for an hour, it will cover a distance of 60 km. (Measuring this deflection has become a standard practice at every total eclipse since the first measurements were made during
the total eclipse of 1919.) A photograph taken of the darkened sky around the eclipsed Sun reveals the presence of the nearby bright stars. In Chapter 8 we discussed a charged balloon that sticks to a wall. We now seriously question the idea of continued growth. Not for certain species of ants of the genus Cataglyphis, which thrive at this searing the total eclipsed Sun reveals the presence of the nearby bright stars. In Chapter 8 we discussed a charged balloon that sticks to a wall.
temperature. Too hot for life? A 2-kg ball weighs 20 N, so the pressure is 20 N/cm2 = 200 kPa. 53. The primary of a transformer connected to 120 V has 10 turns. Hewitt 609: (left) EROS Data Center, U.S. Geological Survey 610: (right) Robert Simmon/ NASA 611: W.H. Hodge/Photolibrary/ Peter Arnold, Inc. Clean
snow is a good reflector and therefore does not melt rapidly in sunlight. To remove most grime, we can use a nonpolar solvent, such as turpentine, which dissolves the grime because of strong induced dipole-induced dipole attractions. How many oxygen atoms are indicated on the right side of this balanced chemical equation? ** A skydiver's air
resistance is proportional to speed squared. Eventually, the rates allow only water molecules to pass. There are three types of strain: Compressional stress occurs when slabs of rock are pushed together. The strongest concentration of light intensity for red, however, is near the maximum angle of 42°, as shown in
Figures 11.45 and 11.46. Ether An organic molecule containing an oxygen atom bonded to two carbon atoms. In fair skin, it can travel deeper. These ions are no longer added to detergents because they cause excessive growth of algae in aquatic habitats that receive the wastewater. (b) is ahead and to the east of the cold front. F I G U R E 1 8 .1 2 (b)
(a) (a) The pH of a solution can be measured electronically using a pH meter. Which is the most reduced in terms of the fewest number of oxygen atoms per carbon atom? Newton's second law of motion The acceleration produced by a net force on an object is directly proportional to the net force, is in the same direction as the net force, and is
kinetic energies. But because there are so many hairs, the surface area of contact is relatively great, and hence the total force of attraction is enough energy to keep the interior hot, generate magma, and provide warmth
to natural hot springs. The most common plutonic rock is granite. But if your feet and the ground are wet, there is a lowresistance electrical path between you and the ground. 7 Power 3. Two kilograms of anything has twice the inertia and twice the mass of 1 kg of anything else. Draw all the structural isomers for hydrocarbons that have the
metals, however, take part in heat conduction than in electric conduction.) 83. The Archean eon—rain, seas, banded iron formations, photosynthesis, stromatolites. F ifty years after Faraday and Henry discovered electromagnetic induction, Nikola Tesla and George Westinghouse put those findings to practical use and showed the world that electricity.
could be generated reliably and in sufficient quantities to light entire cities. After some thought, the peasant asked, "Yes, I understand all that. Physical science is symmetrical. This attraction between water and molecular oxygen is vital for fish and other forms of aquatic life that rely on molecular oxygen dissolved in water. Calculate the work done in
lifting a 100-N block of ice a vertical distance of 5 m. LEARNING OBJECTIVE Discuss how the pH of rain and the oceans is affected by atmospheric carbon dioxide. You drop a soccer ball off the edge of the administration building on your campus. Measurement of changing air pressure is important to meteorologists in predicting weather. If the
atmospheric pressure increases, then the atmosphere pushes down harder on the mercury in the dish and pushes the mercury higher in the tube. (c) result in lowered temperature. FIGURE 25.6 The layer of campfire smoke over the lake indicates a temperature inversion. Rather, you have a different structural isomer, such as isopentane, which has
its own range of different conformations. How many different types of molecules are shown altogether in the three boxes? Simply put, science asks how, art asks who, and religion asks why. An everyday example of metamorphism is potter's clay. (b) The ionic compound sodium fluoride, NaF, is often added to municipal water supplies and toothpastes
does a rain-shadow desert form? (d) sugar molecules solidify as crystals. For instructor-assigned homework, go to www.masteringphysics.com S U M M A R Y O F T E R M S (KNOWLEDGE) Archimedes' principle An immersed body is buoyed up by a force equal to the weight of the fluid it displaces (for both liquids and gases). 4.4 Universal Gravitation
EXPLAIN THIS How did Newton's laws affect the U.S. Constitution? From Figure 11.33 or 11.34, find the complements of cyan, yellow, and red. When it changes into a solid? A fission reactor contains four components: nuclear fuel, control rods, moderator (to slow neutrons, which is required for fission), and liquid (usually water) to transfer heat from
the reactor to the turbine and generator. How do we know that it varies? Sand and glass, for example, are soluble in hydrofluoric acid, HF, which is used to give glass the decorative frosted look shown in Figure 16.18. Discuss and defend your time rising equals your time falling,
hang time is time up plus time down. 2 He 4.003 8 O 15.999 16 S 32.066 34 Helium, He, has an atomic mass of 4.003 amu, and neon, Ne, has an atomic mass of 20.180 amu. It is a measure of a solid's ability to recover its shape once a deforming force is removed from it. Principal quantum number n An integer that specifies the quantized energy level
of an atomic orbital. How far away is Proxima Centauri in Earth-Sun distances? After the fall of the Soviet Union, the wells were capped to prevent this venting. 740 PA R T F O U R ASTRONOMY F I G U R E 2 7. Contributing Mass of 12C SAM PLE PROBLEM 1 Carbon-12 has a mass of 12.0000 amu and makes up 98.89% of naturally occurring
carbon. If the rubber band breaks when stretched, it means that the elastic limit was exceeded. ... S. Which theory for the fate of the universe assumes that dark energy will grow stronger? Water vapor is less dense than air. Although their foraging paths zigzag over the desert floor, their return paths are almost straight lines to their nest holes. 6.7
Specific Heat Capacity 23. Coulomb's law The relationship among electrical force, charge, and distance: If the charges are unlike, the force is attractive. Boiling point/ Solubility Substance 65°C infinite H CH3 O 117°C 8 g/100 mL H CH3CH2CH2CH2 O H CH3CH2CH2CH2 O 138°C 2.3 g/100
mL 424 PA R T T W O CH E M I S T RY 50. Because it removes the ions that make water hard, sodium carbonate is known as a water-softening agent. When the boat's orientation and speed are such that the wind seems to shift in direction, so the wind moves parallel to the sail rather than into it, forward acceleration ceases—at least in the case of a
flat sail. We R considered a plane tilted such that the speed of a rolling ball increases at the rate of 2 meters per second each second—an acceleration of 2 m/s. For example, in 2010, using NASA's Fermi gamma ray space telescope, astronomers discovered two massive gamma-ray-emitting bubbles extending north and south from the center of our
galactic disk, as shown in Figure 27.32. The total current is equal to the sum of the currents through each branch of the parallel circuit. The second is the discovery of cosmic background radiation, which is the Big Bang's afterglow. If a cure for aging were found, the rate of population growth would not be so high as one might expect. Then slightly
tilt the front edge of your hand upward and notice the lifting effect as air is deflected downward from the bottom of your hand. Where do you weigh more: at sea level or on top of one of the entire planet, with all its oceans, mountains, and inner
discovered. Strong bonds are generally found between highly charged ions—the greater the attraction, the stronger the bond. What role do neutrons play in the atomic nucleus? 84. One is your push and the other is the force of friction that acts in the opposite direction. 2 Impulse Changes Momentum 3. The most common temperature scale used in
the United States is the Fahrenheit scale, named after its originator, the German physicist D. An infrared camera reveals the heated tire track (the red streak on the floor, left) and the warmth of the tire (right). Mantle The middle layer in Earth's interior, between the crust and the core. If she stopped at this point for a picnic, would Earth continue to
rise? Because of the cooling effect of the boiling, the water remains at 100°C instead of getting hotter. The pot on the right contains 3 L of water. We speak of an object's natural frequency, which depends on such factors as the elasticity and shape of the object. Chlorine atoms in the stratosphere catalyze the destruction of Earth's ozone layer. Thus, a
10,000-ton ship must be built wide enough to displace 10,000 tons of water before it immerses too deep in the water. If the acceleration of the spaceship were equal to g, the occupants could well be convinced the ship was not accelerated at 2 m/s2. Except for such light
sources as lamps, lasers, and gas discharge tubes, most of the objects around us reflect rather than emit light. But something else is important in changing momentum: time—how long a time the force acts. How many electrons are shared in a double covalent bond? At what point did the universe's temperature even out? Regionally metamorphosed
rocks are found in all the major mountain belts of the world. Every part of their bodies is at the same high potential as the wire, so they feel no ill effects. Because the formation of these similaryet-different minerals depends on temperature and pressure, a polymorph is a good indicator of the geological conditions at the time and place of its formation.
The amount of friction between two surfaces depends on the kinds of material and how much they are pressed together. It is not a scaled-up version of an atom, but instead is a representation that accounts for the atom's behavior. This carbonic acid partially dissolves limestone rock and creates unusual erosional features. Is the stream of water
charged? An object rises in air only when the buoyant force exceeds its weight. If an object is cooler than its surroundings, its rate of warming up is also proportional to ©T. Do people listen to these astrologers just for the fun of it? Down any group (vertical column), the properties of elements tend to be remarkably similar, which is why these
elements are said to be "grouped" or "in a family." As Figure 12.13 shows, several groups have traditional names that describe the properties of their elements. Most of the energy during the collapse of the iron core is released in the form of neutrinos—nearly massless subatomic particles that rarely interact with matter. No! This label indicates that it
contains the hydrogen chloride salt of phenylephrine, not acidic hydrogen chloride. 8-ball system (a) (b) Cue-ball + 8-ball system (c) whole. Interestingly, without the neutron energy carrier, a fusion reaction won't occur. What can be both good and poor at the same time? Because of its high volatility at room temperature, inhaled
diethyl ether rapidly enters the bloodstream. Instead, atmospheric gases (mainly water vapor and carbon dioxide) absorb the long-wavelength terrestrial radiation, keeping Earth's surface warmer than it would be if the atmosphere were not present. Look at the ground the next time you're going on a picnic. Note that the struck coin moves at right
angles (perpendicular) to the contact edge. Then when it returns, it has no KE and stops short of bumping the instructor's nose.) 99. If both the net force and the mass are doubled, then the acceleration will be unchanged. For your information, the ratings are as follows: Compound Pentane Isopentane Neopentane Octane Rating 61.7 92.3 116
FIGURE 19.5 Octane ratings are posted on gasoline pumps. Here are the dates for upcoming lunar eclipses viewable in North America. We are fortunate that charged particles are deflected by magnetic fields. Medium-range forecasting predicts weather for the third to seventh days in less detail. Science Has Limitations EXPLAIN THIS How do the
domains of science and the supernatural differ? SAM PLE PROBLEM 1 How much force, or thrust, must a 20,000-kg jet plane develop to achieve an acceleration of 1.5 m/s 2? When you double the charge on both particles in a pair, what effect does this have on the force between them? Spiral galaxies, such as the Andromeda galaxy, shown in Figure
27.22, are perhaps the most beautiful arrangements of stars. DISCUSSIONQUESTIONS (EVALUATION) 78. The sum of the upward tensions is equal to the scaffold. The answer is that it's directly below this point. Will the readings differ? Isn't it more noble to accept nonzero risk and to
minimize risk as much as possible within the limits of practicality? V F I G U R E 11. It is important to know that hydrogen is not a source of energy. VIDEO: Electron Waves 312 PA R T T W O CH E M I S T RY (a) (b) FIGURE 12.27 (a) An electron microscope makes practical use of the wave nature of electrons. 400: (b left) Shutterstock 400: (b middle)
Shutterstock 400: (b right) John Suchocki/Paul G. Compressions The wavelength of a sound wave is the distance between successive compression has to do with
the ideas of the quantum hypothesis introduced in Chapter 12. Pulsars, which are neutron stars, are rapidly varying sources of low-frequency radio emissions. Then again, there may be nothing. (c) doubles. (b) The caprylaldehyde is a gas at room temperature. records motion Energy released during an earthBedrock quake travels in the form of
seismic Motion of support waves and radiates in all directions within Earth's interior. If two vibrations occur on other planets, all without oceans. Zooming out farther we find that the network of superclusters extends to the edges of the observable universe,
as illustrated in Figure 27.38. The size of a star is the result of these two continually competing processes. What doesn't melt? As previously mentioned, rainwater is naturally acidic. Most of the coal and petroleum that exists today was formed between 280 million and 395 million years ago when plant and animal matter decayed in the absence of
oxygen. This would lead to more precipitation, which would remove carbon dioxide from the atmosphere. The arrows represent domains; the head is a north pole and the tail is a south pole. Friend from college days, Howie Brand illustrates impulse and changes in momentum on page 65. In the Doppler effect, does frequency change? How can a
certain note sung by a singer cause a crystal glass to shatter? Note that, no matter how complicated the collision of balls, the momentum along the line of action after impact and that the components of momenta perpendicular to this line of action
cancel to zero after impact, the same value as before impact in this direction. We know the time and speed, so we can rearrange the basic equation as distance = rate * time. Some of this released thermal inertia. The wood has a higher specific heat capacity than the metal.
Water displaced FIGURE 5.8 FIGURE 5.8 FIGURE 5.9 F I G U R E 5.1 0 The greater pressure against the bottom of a submerged object against the bottom of a submerged object against the gravitational field of the
Earth, work is required to push a charged body. Besides living very, very far away, the only measurable difference is that he or she has already finished reading this paragraph. The pressure would be zero at - 273°C. They had no idea of the concept of inertia. After this happens, will the slowing of time on
the Sun's surface be more or less pronounced than it is today? (120 V)2 V2 V2 55. Boiling water Steel wool Ice 34. Physics is the study of the fundamental rules of nature, which more often than not are rather simple in their design and readily described by mathematical formulas. These three sources of heat—impact heating, gravitational contraction
heating, and radioactive decay heating—acted together to bring young Earth to its melting point. If each of the two headlights draws 3 A, show that your battery will go dead in about 10 h. And we switch to specific heat capacity expressed in joules per kilogram per degree Celsius. Maglev trains are already operational. 3 The Inner Planets 26. When
the weight of displaced air equals the total weight of the balloon, upward motion of the balloon ceases. In a direct sense, no. The answer in meters is 5t 2 (or, more precisely, 4.9t 2). (c) both (d) neither 10. If countries then decide to turn to breeder reactors, they may well find themselves digging up the radioactive wastes they once buried. The
formation of midlatitude cyclones is closely tied to the interactions between air masses at the polar front. Arrange as many upright dominos as you can in this fashion so that they fan out as shown in the photograph. For the short-range projectile motion on the playing field, Earth can be considered flat because the flight of the baseball is not affected
by Earth's curvature. The coils are wound on an iron core so that the magnetic field of the primary passes through the secondary. Neon signs require about 12,000 V for their operation. Earthquakes occur at plate boundaries; about 80% of them are found in the area of the Pacific Rim. The process of falling with the curvature of Earth continues from
tangent line to tangent line, so the curved path 8 km of the same (Figure 20.11). The first reason was that he feared persecution; a theory so
completely different from common opinion would surely be taken as an attack on established order, c, 4. Bow wave The V-shaped wave made by an object moving across a liquid surface at a speed greater than the wave speed. Numerical subscripts indicate the ratio in which the atoms combine. Suppose that people along its length breathe on it so as
to raise its temperature by 1°C. Do you think he will be successful? 40,000,000 J/L work = = 80,000 m/L = 80 km/L force 500 N Sources of Energy EXPLAIN THIS How can the Sun be the source of hydroelectric-, wind-, and fossil-fuel power? In what direction do compressed regions and rarefied regions of a longitudinal wave travel? As the air
beneath the funnel is drawn into the core, the funnel cloud descends toward the surface. add two vectors, make a parallelogram with two component vectors acting as two of the adjacent sides (Figure B.2). The hydroxyl group consists of an oxygen bonded to a hydrogen. Why does Lillian's hair stand out? This is how syrups and hard candy are made.
This forecast is based on weather types that develop in certain areas. What is this structure called? They both use metaphors to help us understand abstract concepts and relationships. One coulomb (symbol C) is equal in magnitude to the total charge of 6.25 * 1018 electrons. The plastic from these bottles could be used to make 74 million square feet
of carpet. Hydrocarbons are obtained primarily from coal and petroleum. This attraction is similar to that which occurs between water and oil molecules. EXPLAIN THIS C ompared with the outer planets, the four planets nearest the Sun are close together. The Sun's glow is visible to the eye; Earth's glow consists of longer waves and isn't visible to
the eye. (d) none of the above. Suchocki, John. Between current and voltage, (a) which remains the same for a 10-\(\frac{1}{3}\) and a 20-\(\frac{1}{3}\) resistor connected in a series circuit? It is also offset by the growing Before it reaches the catalytic converter, popularity of SUVs (sport-utility vehicles), the exhaust contains such pollutants as NO, CO, and hydrocarbons. This
is because each vibrates differently when striking the floor. The amphoteric reaction between two water molecules is endothermic, which means the reaction requires the input of heat energy in order to proceed: Sn2 + 2 Ag h Sn + 2 Ag h
bring it from rest to that speed, or the work the object can do while being brought to rest: Net force * distance = kinetic energy ultimately becomes heat energy. Mesozoic era The time of middle life, from about 248 million years ago
to 65 million years ago. Name the cloud group to which each of the following cloud types belongs: (a) altocumulus, (b) cirrostratus, and (d) cumulus. This ultrasonic squeaks and locate objects by their echoes. Not every piece of iron is a magnet, because
the domains in ordinary iron are not aligned. (b) We see in Figure 11.18 that the wavelength of light is shortened when passing through a transparent material. Almost no one, upon casual inspection, CHAPTER 4 sees the nearer hand as four times as big. Why do its two balanced water-filled caissons weigh the same regardless of what the boats
weigh? An alternative that does respond well to spurts of energy input is a spinning flywheel. It is easy to project a growing reliance on distillation and the third (d) None; all state what does happen. Terminal speeds are reduced when a skydiver wears a wingsuit
(Figure 2.11). From the text you should know that 16 g of methane, CH4, is 1 mole (formula mass 16 amu). A fuel cell, on the other hand, doesn't have this limitation. The average Earth-Moon distance is 3.8 * 108 m. By any method you choose, determine your average walking speed. Changes at the international level will likely be worldwide economic
reform, and at the personal level a reevaluation of the idea that scarcity is the basis of value. On the other hand, potential difference is the same as voltage—the difference in electric potential between two points—also in units of value. On the other hand, potential between two points—also in units of value.
solution as judged by the concentration of hydronium ions. The inward-flowing air spirals because of the Coriolis force (Chapter 24). The power of a tornado is terrifying and devastating. Place an ice cube at the center. A popular one in China currently carries passengers quickly and quietly at speeds topping F I G U R E 9.1 3 A magnetically levitated
train—a magley. Chemical explosions typically involve the transformation of an unstable solid or liquid chemical into more stable gases that occupy much more volume. Recall from Section 15.6 that the electronegativity of an atom describes how well that atom is able to pull bonding electrons toward itself. We discuss the important role that neutrons
play in holding the atomic nucleus together in Chapter 13. (a) Show that the temperature increase of the ball is 1.1°C. They are meant solely as a review of reading comprehension. So the illusion that an object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists behind a mirror (or, in some cases, in front of a concave mirror) is merely due to the fact that the light from the object exists a concave mirror (or, in some cases) is mirror (or, in some cases).
exactly the same manner, physically, as it would have entered if the object really Your image behind a plane were at the image location. As a result, there is no net consumption of chlorine. The path would be the same if the light entered from the right and exited at the left. The nucleus is composed of protons and neutrons. In 1994, Comet Shoemaker-
Levy collided spectacularly with Jupiter, as shown in Figure 26.45. 774 PA R T F O U R ASTRONOMY BIG BANG HELIUM As the universe expands, it cools. When the man pulls his arms and the whirling weights inward, he decreases the radial distance between the weights and the axis of rotation, and the rotational speed increases correspondingly.
Figure 10.6b shows the generation of a transverse wave. Some forces can change potential energy as those left behind? Size is also an indication of distance traveled: Particles become smaller the farther they travel. In
what way are magnetic poles very different from electric charges? 714: (top) Fred Espenak/Photo Researchers, Inc. If we do not know this distance, we cannot calculate the force. If it emits more than it absorbs, it is a net emitter and its temperature drops. What is the relationship between dark energy and Einstein's cosmological constant? This
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activity demonstrates how radioactive decay is a statistical phenomenon. The force on the bus is Ma. Ma 6Ma 6Ma 6 same force = = = a. As late as the beginning of the 20th century, many astronomers believed the universe consisted of a finite number of stars bunched together within an infinite space. In the formation of sodium chloride, these
atoms transform into positively charged sodium ions, which occurs as sodium atoms lose electrons (oxidation). He was interested in Jupiter at the time, and so he merely plotted Neptune as a background star. Astronauts who venture from Earth, for example, will need all the techniques available for coping with unfamiliar environments. Places where
the upper air is exceptionally dry, such as Italy and Greece, have beautiful blue skies that have inspired painters for centuries. The crests of the higher Tg? When does a star die? The fuel for fusion—hydrogen—is found in every part of the
universe, not only in the stars but also in the space between them. The lithosphere is, in a sense, riding on top of the asthenosphere like a raft on a pond. Similarly, an atom has only a limited energy levels. Ask your friend to count how
many rotations the penny makes in one revolution (orbit) around the quarter. Fossils not only tell the story of life on Earth, they also give us important clues about Earth's geologic past. Atomic spectrum The pattern of frequencies of electromagnetic radiation emitted by the atoms of an element, considered to be an element's "fingerprint." Atomic
symbol The abbreviation for an element or atom. Raising the potential energy of the atoms in the product molecules requires a net input of Potential energy Nitrogen monoxide, NO Nitrogen, Oxygen, N2 O2 F I G U R E 17. Because the sodium causes reduction of the chlorine, the sodium is acting as a reducing agent. 9 ercase letter (m for maritime, c
for continental). Therefore, we see, from the law of gravitation, that the Sun, the Moon, and Earth are spherical because they have to be (although rotational effects make them slightly ellipsoidal). C H A P T E R 17 H O W CH EM I C A L S R E AC T 439 CHECKPOINT What kitchen device is used to lower the rate at which microorganisms grow on
food? (c) both of these (d) none of these 8 C H A P T E R 8 Static and Current Electricity I f you are connected to an electrostatic 8. Whenever matter changes phase, a transfer of thermal energy is involved. Formulate the simplest general rule that organizes the hypothesis, predicted effects, and experimental findings. To be safe use the recommended
voltages for all appliances. What is the relationship between a neutron star and a pulsar? The remarkable colors of the ponds are due to organic pigments made by salt-loving bacteria. Can you think of a practical application at a traffic intersection? So. Why is a tub of water placed in a farmer's canning cellar in cold winters to help prevent canned
food from freezing? To represent the solid phase, gently vibrate the balloon. What cloud form is associated with thunderstorms? If you cover the top of the can firmly with the palm of your hand, the flow stops. 4 Archimedes' Principle 5. No matter how the temperature is produced, a problem is that all materials melt and vaporize at the temperatures
required for fusion. For protons that are close together, as in small nuclei, the attractive strong nuclear force easily overcomes the repulsive electric force. Similarly, baking soda has the chemical property of reacting with vinegar to produce carbon dioxide and water while absorbing a small amount of heat energy. Does the velocity of the dart affect
your answer, assuming that it is great enough to travel the horizontal distance to the tree before hitting the ground? Show that the output voltage is 1200 V. With other wavelengths, as shown in Figure 12.28c, successive waves are not synchronized. Ft = (25 N)(2 s) = 50 Ns = 50 kg # m/s. The direction of the field outside the magnet is, by
convention, from the north pole to the south pole. Mesozoic—age of reptiles, dominance and diversification of dinosaurs!!). This break site, the point of origin where the rock initially slips, is called the focus (Figure 21.36). These vapors
travel through the copper pipes, where they then condense to a liquid. Observe the spout of a teakettle full of boiling water. Because our eyes are sensitive to the contrast with the illuminated parts of the screen, we see this gray as black. If your kid sister doesn't believe air has weight, maybe it's because she's always surrounded by air. You can feel
the resulting tingly dioxide molecules originally dissolved in the liquid can escape into sensation. 8 The Force of Friction 1. If the water is bumped or jarred just enough to cause the bubbles to form rapidly, they'll violently expel the hot water from its container. Although the moist adiabatic lapse rate varies according to the temperature and g lin o the
moisture content of air, on average a saturated air Co parcel cools by about 6°C for every kilometer it rises. When these pure tones are sounded together by selecting the proper keys on an electric organ, they combine to produce the tone of the violin. Polymorphs Two or more minerals that contain the same elements in the same proportions but have
different crystal structures. Many additional black hole candidates have since been found, which suggests that black holes are common. Pascal was an invalid at age 18 and remained so until his death at age 39. Valence electrons can be conveniently represented as a series of dots surrounding an atomic symbol. The quasar is brighter! 29. If all three
kids were equally greedy, then the situation would be more balanced—that is, nonpolar. If an electron is removed from an atom, the atom is no longer neutral. FYI Temperature Changes and Condensation As an air parcel rises, it expands. When in equilibrium on a firm surface, weight is evidenced by a support force, or, when in suspension, by a
supporting rope tension. They change their minds, however, only when confronted with solid experimental evidence or when a conceptually simpler hypothesis forces them to a new point of view. A common inactive ingredient in products such as sunscreen lotions and shampoo is triethanolamine. 91 LEARNING OBJECTIVE Define and describe
Newton's law of universal gravitation. The speed of sound varies with (a) amplitude. Because of bouncing, the air-sail force is greater. What kind of motion should you impart to a stretched coiled spring (or to a Slinky) to produce a transverse wave? (a) For a fusion reaction to occur, the nuclei must collide at a very high speed in order to overcome
their mutual electric repulsion. For example, the sulfate mineral gypsum is used for making plaster, and the halide mineral halite is common table salt. The loss of metallic iron ruins the structural integrity of these objects. Finet = ma = (1 kg)(10 m/s2) = 10 kg # m/s2 = 10 N. Relative humidity is the ratio of the air's water-vapor content to the air's
water-vapor capacity at a certain temperature. Within months there were 1.3 million new cases of cholera resulting in 13,000 deaths. No. Bond energy depends on the types of atoms bonding. (b) magnetic fields. hen the ends of a heat conductor are at different temperatures, heat energy flows from the higher temperature to the lower temperature
What would he have given to have access to the science textbooks of the 21st century? Each of these tones has a characteristic sound that differs in quality, or timbre, a mixture of harmonics of different intensities. An atom, therefore, does not actually contain a series of concentric shells; it merely behaves as though it does. How many periods are
there in the periodic table? 14.2 The Submicroscopic World 4. At greater muzzle velocities, orbiting cannonballs trace the famil(a) (b) iar external ellipses. Would any of its fuel go unused? The zebralike pattern was found to run parallel to the coastlines and in other parts of the ocean floor. If a moving car speeds up until it is going twice as fast, how
much kinetic energy does it have compared with its initial kinetic energy? If dark energy gains strength, then the ultimate demise of our universe may be the Big Rip. A longitudinal wave? In an aldehyde, the carbonyl carbon is bonded either to one carbon atom and one hydrogen atom, as in Figure 19.20b, or, in the special case of formaldehyde, to
two hydrogen atoms. Felix Hoffman, a chemist working at Bayer, added the acetyl group to the phenol group of salicylic acid in 1897. Interestingly, although the radius of Antares is 700 times that of our Sun, its mass is only about 15 times greater. Power transmission is more efficient at higher voltages, so Europe adopted 220 V as its standard. We
won't go through the calculation here, but 62 MJ/kg corresponds to a speed of 1.2 km/s, whatever the total mass involved. Today an element is identified as a material consisting of only one kind of atom. Show that a certain 1.2-m-long wave with a frequency of 2.5 Hz has a wave speed of 3.0 m/s. S-8 O D D - N U M B E R E D S O LU T I O N S 43.
Hewitt 398: Don Geddis 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top right) iStockphoto 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top right) iStockphoto 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top right) iStockphoto 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top right) iStockphoto 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top right) iStockphoto 399: (top left) Richard Megna/ Fundamental Photographs, NYC 399: (top left) Ri
beach when a strong wind blows and being constantly pelted by tiny sand grains blowing in the wind. 5 The Laws of Thermodynamics 6. We all know that a baseball pitcher can throw a ball in such a way that it curves to one side as it approaches home plate. Something is electrically charged when it has an excess or deficiency of electrons compared
with the number of protons in the atomic nuclei of the material. We'll return to the oceans and their important interplay with carbon dioxide in Chapters 18 and 24. EXPLAIN THIS J ust as you can't enjoy a ball game, computer game, or party game until you know its rules, so it is with nature. Astronomers thus follow an alternate explanation for why
the spectra of galaxies show redshifts. A marble rolling past this warped surface would trace a bent path, as shown in Figure 28.8. If the marble were to roll closer to the ball, it might trace an elliptical curve around the ball. If the stream will flow faster
because there is less contact with the channel. (b) If the mass of the egg is 1 kg, its initial speed is 2 m/s, and the time to stop is 1 s, show that the average force on the egg is 2 N. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases because the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force on the egg is 2 n. Acceleration decreases the net force of the egg is 2 n. Acceleration decreases the net force of the egg is 2 n. Acceleration decreases the net force of the egg is 2 n. Acceleration decreases the
as all the water in it has frozen. When we use a scanning probe microscope, do we see atoms directly or only indirectly? So a good absorber appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark, and a perfect absorber reflects no radiant energy and appears dark appears 
on a tree. CHECKPOINT As the Sun gets older it also gets hotter. His graph showed a clear relationship—the farther away the galaxy, the greater the velocity of the galaxies from us, and the greater the velocity of the galaxy, the greater the velocity of the galaxies from us, and the greater the velocity of the galaxy, the greater the velocity of the galaxy and the greater the velocity of the galaxy.
need to travel to the front side of the Moon. The composition of an alpha particle is the same as that of the nucleus of a helium atom. Because of the polarity of the oxygen-hydrogen bond, low-mass alcohols are often soluble in water, which is itself very polar. He compared the motion of the Moon to that of a cannonball fired from the top of a high
mountain. Energy reflected by the greenhouse is energy not absorbed. Once these molecules and form a sugar-tea-water mixture. The acceleration is the same as before. He is sure that the lead is very hot and his finger is thoroughly wet before he does this. If the
planets all orbited the Sun at about the same speed, we might conclude that most of the solar system is not concentrated in the center of the solar system. The number of electrons that each shell can hold corresponds to the number of electrons that each shell can hold corresponds to the number of electrons that each shell can hold corresponds to the solar system.
For a gas, we refer to how fast the gas particles are bouncing back and forth; for a liquid, we refer to how fast they slide and jiggle past each other; and for a solid, we refer to how fast the particles move as they vibrate and jiggle past each other; and for a solid, we refer to how fast the particles move as they slide and jiggle past each other; and for a solid, we refer to how fast the particles move as they vibrate and jiggle past each other; and for a solid, we refer to how fast the particles move as they vibrate and jiggle past each other; and for a solid, we refer to how fast the particles move as they vibrate and jiggle past each other; and for a solid, we refer to how fast the particles move as they vibrate and jiggle past each other.
provide an explanation for the existence of pulsars. The answer can be found by using water as an analogy. False, because a sonic boom occurs for aircraft moving faster than the speed of sound. This is the diurnal motion of the stars. CHECKPOINT 1. area called a station model. (b) transmitted. As in the preceding question, speed doesn't change
when there is no component of gravitational force in the direction of its motion. These minerals are often deposited in cracks, and sometimes within the rock matrix itself. The rest of the motion occurs along other faults (such as the Hayward Fault). But energy comes in various forms and can easily be transformed. 5.4 Archimedes' Principle 11. Try
this in the bathtub or when you're washing dishes: Lower a drinking glass, mouth downward, over a small floating object. For a mega-sized black hole, like the one at the center of our galaxy, the tidal forces would be negligible—your spaceship would survive passage through the event horizon. Coulomb's law underlies the bonding forces between
molecules that are essential in the field of chemistry. A high-power automobile engine does work rapidly. How is a solution different from a suspension? When you effectively compress a spring inside. For example, lifting a large boulder off the bottom of a riverbed is a relatively easy task as long as the boulder is below
the surface. pseudoscience, 6, 190 Scientific attitude, 3-5 Scientific methods, 3 Scientific research, basic vs. FIGURE 25.2 Condensation of water molecules. We are also grateful to Lillian Lee Hewitt for extensive editorial help. See also Ion(s) Moles, 404 conversion to grams, 432-435 Momentum, 61-70 bouncing and, 65-66 collisions and, 68-70
conservation of, 67-70 decrease in, 63-65 impulse and, 63-65 impulse a
astronomy is one and astrology is another. Elements heavier than iron, therefore, are created within the rare moments of a supernova blast when there is abundant energy to allow the endothermic (energy requiring) fusion of iron into heavier elements. Discuss how whiplash involves the concept of inertia and why cars are equipped with headrests
And why is this effect opposite to what happens to the drum in the preceding question? Over time, sediments of sand and clay buried the peat. Milk, a natural product, is a mixture. Inertia in action. Standing waves are produced when two sets of waves of equal amplitude and wavelength pass through each other in opposite directions. The buoyant
force does not change. Quartz has a more complicated structure with no layering and no planes of weakness. CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E 773 FIGURE 28.4 Arno Penzias and Robert Wilson in front of the microwave receiver they used to detect the afterglow of the Big Bang. The vector that pokes outside the
dashed line represents an external force on the system. Does that mean it has several thousand joules of energy? Isotopes and Atomic Mass For any element, no set number of neutrons are in the nucleus. According to recent evidence, how long ago did the expansion of the universe start accelerating? Absorption! So sand and other things look darker
when wet. This could be proven wrong if paleontologists were to find that more complex forms of life appeared before their simpler counterparts. (b) C7H12. So energy from the Sun gets into the car interior, where, except for reflection, it is absorbed. When the molecules of steam inside the can hit the inner wall, they bounce—the metal certainly
doesn't absorb them. If we were to speed up sufficiently, we would escape this curvature and leave the Sun for good. Rock melts into magma (a topic of much discussion in Part 3). Energy is most evident when it is changing. We begin with physics, the basic science that provides a foundation for chemistry, which in turn extends to Earth science and leave the Sun for good.
astronomy. This is caused by a difference in the speed of light in the transparent media. A wall of appropriate thickness retains the warmth of the house at night by slowing the flow of thermal energy from outside to inside. The stars in the
nighttime sky change in a yearly cycle. Not all debris, however, was pulled fully into the jovian planets. Component T is a useless force that tends to tip the boat over and move it sideways. Light is deflected as the bullet passes through the compressed air that makes up the shock wave, making it visible. For the smaller angle, of course, the object
remains in the air for a shorter time. Saturn has about 50 moons beyond its rings. The apparent weight of a submerged object is its weight out of water minus the buoyant force. What is a copolymer? Rank the amount of tension in the rope in his right hand (the one attached to the tree in B and C) from least to greatest. In other words, parallel lines
would never touch. Whenever work is done, energy is exchanged. Three ethanols surround a central nitrogen atom. CHECKPOINT What is the solvent in the gaseous solution we call air? With this knowledge, scientists can calculate the age of carbon-containing artifacts, such as wooden tools or skeletons, by measuring their current level of
radioactivity. 10 C H A P T E R 1 0 Waves and Sound M any things in the world 10. Two oxygen atoms have a mass of about 32 amu, as does a single oxygen molecule, O2. This process cascades through the glass, with the result being that the "bullet of light" emerging is not the same "bullet" that was first incident. If you stopped an Earth satellite
dead in its tracks—that is, reduced its tangential velocity to zero—it would simply crash into Earth. Ink-jet printers deposit various combinations of cyan, magenta, yellow, and black inks. Why would it be futile to attempt to detect sounds from other planets with the use of state-of-the-art audio detectors? For this to happen, each monomer must
contain at least one double bond. Are these severe weather events related to global warming? The geologic structures we see at Earth's surface, such as folds, faults, and related mountains, are examples of strain from tectonic stresses that exceeded the strength of the rock. The positive terminal of the battery is connected to an electrode made of the
coating metal. Calcium and magnesium ions are more attracted to sodium carbonate than to soap. Power is also the rate at which energy is changed from one form to another. Can you also see that fracture zones are former transform faults? Domains in the can tend to line up with Earth's magnetic field. Scientific Methods 4. With no gravity, the pathons are former transform faults?
of a moving object would be a straight line, in accord with the law of inertia. Usually a lunar eclipse precedes or follows a solar eclipse by two weeks. The resulting ash is more compact and takes up less space in a landfill. The greater the shift in the lines of hydrogen's spectrum, the faster the receding speed. impure, 399-400 Maxwell's counterpart
to Faraday's law, 230-231 Melting, 178 Membranes, semipermeable, 416 Mercury, 710, 714-715 Mesosphere, 661 Mesozoic era, 635-636 Metallic bonds, 375-376 Metallic bonds, 375-376 Metamorphism, 545 contact, 546 regional, 546-547
Meteorites, 729 Meteoroids, 729 Meteoroids, 729 Meteoroids, 729 Meteoroids, 729 Microscopes, scanning probe, 360 Microwaves, 192 Middle clouds, 690, 691 Midlatitude cyclones, 697-698 Minerals, 520-554. These two liquids therefore mix together quite well dipoles in any given sucrose moland in just about any proportion. Why are eclipses relatively rare events? (b) There is
no strong scientific evidence that CFCs play a significant role in the catalytic destruction of ozone. This type of electrons is called a covalent bond, in which co-signifies F F sharing and -valent indicates that valence electrons are Fluorine being shared. The
speed it loses while going up is therefore the same as the speed gained while coming down. Helium, however, is a more complex element containing a nucleus of two protons and, 295-296 elements and, 296-297 isotopes and, 298-299 neutrons and
298-299 periodic table and, 296-297, 300-304 physical models of, 306 protons and, 297-299 shell model of, 313-315 size of, 305 spectroscopy of, 308-309 strong nuclear force and, 326-328 vs. Watch out for splattering!) Examine the resulting residue by scraping it off with a knife. Composite cones have a steep-sided summit and gently sloping
lower flanks. The Hadean eon—old, hot, hell, oceanless. Each layer is a concentric sphere, so that Outer core Earth's overall structure resembles Inner that of a boiled egg. Toaster 8 A Heater 10 A Lamp 2A Fuse 20 A Safety Fuses To power company To prevent overloading in circuits, fuses are connected in series along the supply line. Estimate the
mass of air in kilograms in a classroom that has a [email protected] floor area and a 4-m-high ceiling. At the same time, however, we made mistakes in caring for the environment. Stick a paper clip and a piece of copper wire into a lemon. The Sierra Nevada were Asthenosphere Rising produced by subduction magma X Shallow earthquakes of the
ancient Farallon Deep earthquakes Plate beneath the North American Plate. If molecules in the sky were to scatter low-frequency light, what color would the sky be? c, 3. (A rubber band, interestingly, is called elastic because it returns to its original shape when released.) The density of rock beneath Earth's surface
increases because it is compressed by the weight of material above it. So there are distinct advantages to learning about chemistry and other physical sciences before advancing to the life sciences. (c) skylight overwhelms starlight. Wegener described continental drift in his book The Origin of Continents and Oceans, published in 1915. Wave speed
The speed with which waves pass a particular point: Wave A wiggle in both space and time. Nitrogen, N2 Oxygen, O2 . 7 Wastewater Treatment from seawater? extends out several million kilometers (Figure 26.7). Period The time required for a vibration or a wave to make a complete cycle; equal to 1/frequency. In the case of hot rocks at depth, they
are under enormous pressure from the weight of the rock above—enough pressure to prevent melting, even at hotter30 than-magma temperatures. Why doesn't weight affect acceleration? They tend to contain large clouds of gas and dust mixed with both young (blue) and old (yellow) stars. Atoms then combine to make molecules, such as those that
make our bodies. And by Ohm's law, more current for the same voltage means V less resistance. As a water molecule gets close to the sodium chloride, it can distinguish the various ions and it is thus attracted to an individual ion by ion-dipole forces. S-waves cannot
travel through liquids, which implies a liquid outer core. Their effect is small in comparison with the pull of the much more massive Sun, but it still shows. What is a reverberation? (a) A reverse fault before erosion; (b) the same reverse fault after erosion. This is the reason fresh dog poop always smell more foul than week-old dog poop. With nature as
our teacher, we have much to learn. Interior Design: Yin Ling Wong Cover Photo Credit: Lillian Lee Hewitt Photo Research: Eric Schrader Science Image Lead: Maya Melenchuk Illustrations: Dartmouth Publishing, Inc. The pH of the second solution is 4, which is acidic. Consider this from the perspective of Newton's law of
gravity. (Is your answer different if the bucket is initially filled to the brim?) 87. Distance = 60 km/h * 10 h = 600 km Velocity F I G U R E 1 .1 9 Although the car can maintain a constant speed along the circular track, it cannot maintain a constant speed along the circular track, it cannot maintain a constant speed along the circular track, it cannot maintain a constant velocity. FYI Water Sodium cyanide KOH Nitric acid T W O CL A S S E S O F CH EM I C A L R E AC T I O
N S Sodium fluoride Not all neutralization reactions result in the formation of water. The simplest hydrocarbon is methane, CH4, with only one carbon per molecule. O O 

Adipic acid and hexamethylenediamine polymerize to form the condensation copolymer nylon. The attraction the sodium nucleus has 9 protons for its second-shell
electrons, however, is much 10 electrons 9 electrons 9 electrons stronger, which is why the sodium atom rarely -1 net charge loses more than one electron. Note the hydraulic pistons in almost all construction machines where heavy loads are involved (Figure 5.33). 6.7 Specific Heat Capacity EXPLAIN THIS F I G U R E 6 .1 0 Entropy. CHECKPOINT
As a nebula contracts, its rate of spin increases. A cluster of galaxies, therefore, can bend the light from an even farther cluster lying directly behind it—we say the foreground cluster behaves as a gravitational lens. What drives an atom to form a covalent bond: its nuclear charge or the need to have a filled outer shell? Technically, however, any
energy released or absorbed by a chemical reaction arises from the transformation of matter into energy, or vice versa. A battery provides electricity, the hydride ion releases electrons, which allows it to join with the hydroxide ion to
reform water: H: Ni Nickel hydride + HOHydroxide ion h H2 O Water + Ni + 2e- Nickel metal So rechargeable battery simply means regenerating the chemicals, such as nickel hydride, that can release electrons on demand. Which mineral contains more silica? The mass of an atomic nucleus is less than the sum of the masses of the
nucleons that compose it. What role do CFCs play in the catalytic destruction of ozone? Since its charges are balanced, how can sodium chloride be attracted to water, and vice versa? Some debris rains back down on Earth, while some will gradually accrete to become the Moon. They likely orbit the Milky Way. What are clouds made of, and what do
molecules, therefore, leads to a greater number of collisions between these molecules; hence, a greater number of nitrogen monoxide molecules form in a given period of time. That's because these fuels are created by photosynthesis—the process by which plants trap solar energy and store it as plant tissue. This idea was held to be true for nearly
2000 years because of Aristotle's compelling authority. The seal should not be airtight—leave two of the edges open to pressure. Calculate the weight of the car in newton's mountain would follow Earth's curvature and
glide in a circular path around Earth again and again (provided the cannoneer and the cannon got out of the way). They may be partial or total. Why does Hollywood persist in playing engine noises whenever a spacecraft in outer space passes by? 548: (a) Alamy 548: (b) Shutterstock 555: NASA/Goddard Space Flight Center 562: SPL / Photo
Researchers, Inc. SAM PLE PROBLEM 1 An oceanic depth-sounding vessel surveys the ocean floor with ultrasonic sound that travels 1530 m/s in seawater. Which has the greater kinetic energy? N ewton's first law, the law of inertia: An object at rest tends to remain at rest; an object in motion tends to remain in motion at constant speed along a
shock proteins (HSP) in their bodies. Fissure eruptions also occur on land. Impacts of this kind account for many knockouts. It can be a typical fine-grained volcanic rock, or the lava can cool quickly to form volcanic glass—pumice if the rock is riddled with tiny holes from former gas bubbles, obsidian if it lacks such holes, or volcanic ash if it is erupted
92 Rn 222 218 F I G U R E 1 3 .1 7 U Ra 226 210 Pa Tl Pb Bi Po Pb Bi Po 83 84 Tl Pb 81 82 At 85 86 87 88 Atomic number 89 90 C H A P T E R 13 T H E ATO M I C N U CL EU S A N D R A D I OAC T I V I T Y 331 CHECKPOINT 1. Celestial objects generally appear to move westward across the sky. Similarly, outdoor steel pipes are protected by being
connected to magnesium rods inserted into the ground. 5 4 One component of the incident unpolarized light. So farmers had only to replace frozen tubs of water with unfrozen ones, and the cellar temperatures wouldn't fall below 0°C. What Archimedes discovered was a simple and accurate way of
of all manufactured goods are produced with the assistance of catalysts. Another hazard is liquefaction, in which wet sediment during an earthquake behaves like a fluid instead of a solid. The weight of water that overflows (see Figure
5.16). The carbon dioxide of your breath reacts with the water to form carbonic acid, which reacts with the water to form carbonic acid, which reacts with the water to form carbonic acid HOSO HOCOH Carbonic acid HOSO Sulfuric acid Energy + H2O + H2O + H2O H H3O + + OH The warmer the water, the more heat energy is available for this reaction, and the more hydronium and hydroxide ions are
the latest news as it happens through online resources such as those listed in Table 28.1. We begin with how it all began with a bang—the Big Bang. In this case, cloud condensation nuclei are not needed. The air gets cooler due to adiabatic expansion. (d) acceleration. Neap tide A tide that occurs when the Moon is midway between new and full, in
either direction. From the curve, can you see that warm air has a higher saturation vapor pressure than cold air? Common infrared sources that give the sensation of heat are the Sun, a lamp filament, and burning embers in a fireplace. The same is true, to a lesser extent, of nickel and cobalt atoms. Which has the higher frequency? The ammonia
solution, therefore, has the lowest concentration of hydronium ions. ow can you determine whether an observed change is physical or chemical? This foundation material is then revisited in an examination of Earth over geologic time. An ellipse is a specific curve: the closed path taken by a point that moves in such a way that the sum of its distances
from two fixed points (called foci) is constant. What do cosmic inflation and dark energy have in common? The frequency of the original light that produced the vibration. This deformation can be seen in the folded and fractured rock layers in many mountain ranges
(Figure 20.33). Now you know that this diffwhere these electrons play no significant role in the process being illustrated. What is a hydrogen bond? Hewitt 24: Alan Schein Photography/ CORBIS 25: Rick Lucas/Paul G. Because the soap or detergent must be added to
maintain cleaning effectiveness. (c) Composite cones, such as picturesque Mt. Fuji, are also very steep. Which, if either, has greater momentum: a 1-kg ball moving at 2 m/s or a 2-kg ball moving at 1 m/s? When air is rapidly compressed, why does its temperature increase? This is when significant droplet growth occurs. (b) thermal energies at
different temperatures. 12 FIGURE 26.33 15 7 Aug. C H A P T E R 11 A common light source, such as an incandescent lamp, or a candle flame, emits light that is unpolarized. The released energy radiates away from the initial break site as seismic waves. The mobility of electrons in a metal accounts for the metal's significant
ability to conduct electricity and heat. Because S-waves Rayleigh wave (d) travel more slowly than P-waves, they are the C H A P T E R 21 P L AT E T E C TO N I CS A N D E A R T H 'S I N T E R I O R second waves to register on a seismograph. The penalty for fraud is professional excommunication. If the descending air parcel's temperature becomes
warmer—and therefore less dense—than air at the lower elevation, the parcel will rise back to the elevation from which it came. The planetesimals grew into planets at about the same time that the protosun was commencing thermonuclear fusion. Of course, if people really do start to live that much longer, then it's a safe bet that there would be a
shift toward privatized retirement accounts. How does the force of gravity between two bodies change when the distance between them is tripled? The rays diverge from the flame. One of the balloons is then punctured. Even basketball star Kobe Bryant in a standing jump can't raise his body 1.25 m high, although he can easily reach considerably
above the basket, which is more than 3 m high. According to Figure 19.3, which has a higher boiling point: gasoline or kerosene? The "just-married" John and Tracy are flanked by John's sisters Cathy Candler and Joan Lucas on page 256. Held together by gravity, the ordinary matter and dark matter would have been strewn outward in a clumpy
CHAPTER 28 T H E S T R U C T U R E O F S PACE A N D T I M E 783 F I G U R E 2 8 .1 8 Images of dark matter, shown in blue, were created through the Hubble Space Telescope's Cosmic Evolution Survey. We say that such a wave is plane-polarized—that the waves traveling along the rope are confined to a single plane. Would a vacuum cleaner
pick up dust from a rug on the Moon? State the law of inertia. The chemical compositions of marbles and quartzites do not favor the formation of micas. In both photos the Sun is almost behind the two spheres—one sphere being the Moon and the other a Ping-Pong ball. How does the brightness of
a quasar compare with that of a large galaxy? Show that when the time delay of an echo to the ocean floor below is 4 s, the depth of the water is 3060 m. Furthermore, all the electrons of an atom are widely spaced apart. HANG TIME Some athletes and dancers have great jumping ability. The materials become slightly warmer. 69. Weathering
Disintegration or decomposition of rock at or near Earth's surface. This gives rise to a select number of possible scenarios for the fission bomb "trigger" used to ignite the thermonuclear reaction, and some is in fissionable material
that surrounds the thermonuclear fuel. Which person reaches the ground first? The flight of a blimp best illustrates (a) Archimedes' principle. Although minimizing any toxic components in your drinking water is important, removing all other substances from it is unnecessary, undesirable, and impossible. This color indicates that it is only slightly
acidic, so the juices in the cabbage are less acidic than vinegar. Sound waves cannot be (a) reflected. A friend says that molecules in a mixture of gases in thermal equilibrium have the same average speed. Title. A Mercury-sized object collides with Earth, which turns molten. Acceleration g change of velocity time interval g ©v ©t 36. The 1906 Sar
Francisco earthquake, approximately magnitude 7.8 on the Richter scale, resulted in 700 deaths and extensive fire damage. Does voltage flow across a circuit or is it impressed across a circuit? It contains many more stars than the Milky Way, which makes it more luminescent. The area of the Pacific Rim that encircles much of the Pacific Ocean is
often referred to as the "Ring of Fire." About 80% of the world's volcanoes are located here as well. On the ocean floor, basalt is the most common igneous rock. LEARNING OBJECTIVE Describe the evidence for dark matter and
its role in the formation of galaxies. Ice, for example, is the solid phase of water. They differ in their acid strength. (b) Pyrite, or "fool's gold," typically forms cubic crystals marked with parallel lines called striations. An example is Comet Halley, which returns to the inner solar system every 76 years—once in an average lifetime (Figure 26.43). In
bombarding atomic nuclei with proton "bullets," why must the protons be given large amounts of kinetic energy in order to make contact with the target nuclei? and What if? The mechanism of sticking is charge induction. A pair of protons in an atomic nuclei with proton be given large amounts of kinetic energy in order to make contact with the target nuclei? and What if? The mechanism of sticking is charge induction. A pair of protons in an atomic nuclei with proton "bullets," why must the protons be given large amounts of kinetic energy in order to make contact with the target nuclei?
planet from the Sun and, like Mercury, has no moon. They are loose and free to wander, with very little restraint, throughout the material (which is why metal conducts electricity and heat so well). So total tension in the top string is pull plus the weight of the ball. The cause of the dipole in either one of the carbon-oxygen bonds is oxygen's greater
pull on the bonding electrons (because oxygen is more electronegative than carbon). For reasons beyond the scope of this text, oxygen gas is generated only when the positive electronegative than carbon). For reasons beyond the scope of this text, oxygen gas is generated only when the positive electronegative than carbon).
two rock types that form by chemical sedimentation. —Max Born of an electron in an atom. If the photos were taken on the same day (or one month apart), then the Ping-Pong ball must have been held up to the sky aimed right at the Moon. See Electric charge Chemical bonds, 353 Chemical changes, 353-355
Chemical compounds, coming together. To emphasize their particulate nature, each quantum of light was called a photon, and neutron. How should you move the balloon so that the beads represent the liquid phase? Conglomerate is composed of gravel-sized and smaller rounded
rock and mineral fragments. The limbs of a syncline (a down-fold) tilt toward the axis of the fold (a marble would roll toward the axis), and the rocks are youngest at the core. Using Newtonian physics as a model of reason, Locke and his followers modeled a system of government that found adherents in the thirteen British colonies across the Atlantic
The deflected wind sets up a counterclockwise rotation around the central low. Submicroscopic Semipermeable pore membrane For many regions, reverse osmosis is a preferable method of water desalination. Orographic Lifting An air mass that is pushed upward over an obstacle, such as a mountain range, undergoes orographic lifting—the rising air
cools. e, 5. In premodern times, farmers in cold climates prevented jars of food from freezing by taking advantage of water's high heat of fusion. CHAPTER 3 97. Hot air travels upward by air convection. The idea that matter is made up of molecules came about only after many questions were asked about the behavior of matter. A satellite travels
faster when closer to the body it orbits. companies? Time (s) Velocity Acquired (m/s) Distance Fallen (m) 6 60 180 7 70 245 8 80 320 9 90 405 10 100 500 2r (100 m) 2r d 2pr. The car, in turn, pushes back with an opposite but equal force on you. Show that the momentum is 16 kg # m/s for a 2-kg brick parachuting straight downward at a constant
speed of 8 m/s. Would time slow in the artificial gravity produced in a rotating space habitat? A cell can survive an otherwise lethal dose of radiation if the dose is spread over a long period of time to allow intervals for healing. Contact metamorphism is typically associated with high temperatures and high water content—lots of chemical activity and
little or no mechanical deformation. In between the stars you'll also see plenty of black. (c) protons. Why One Side Always Faces Us The first images of the back side of the Moon were taken by the unmanned Russian spacecraft Lunik 3 in 1959. CHAPTER 5 F L U I D M E CH A N I CS 129 FIGURE 5.20 The famous "Magdeburg hemispheres"
experiment of 1654, demonstrating atmospheric pressure. In a broader sense, a force makes up an interaction while moving at a constant horizontal velocity is a parabola. When they jiggle faster, they slide over one another and we have a liquid
FIGURE 2.13 In a vacuum, a feather and a coin fall at an equal acceleration. Write a letter to your grandparents describing how you're learning to distinguish related ideas. Which dominated Galileo's method of extending knowledge: philosophical discussion or
called Snell's law, is credited to Willebrord Snell, a 17th-century Dutch astronomer and mathematician: n1 sin u1 = n2 sin u2, where n1 and n2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface, and u1 and u2 are the indices of refraction of the media on either side of the surface of the surf
speeds (15-25 km/h) for safe landings. 390 PA R T T W O CH E M I S T RY FIGURE 15. * More generally, work is the product of only the component of force that acts in the direction of motion and the distance moved. The copper-coated zinc penny is not an example of a voltaic cell, a device that allows the flow of electrons by permitting a reverse flow
568 Rock(s), 520-549. The greenhouse effect is very pronounced on Venus but doesn't exist on Mercury. (a) Chlorophyll makes grass green. Chemical sediments Sediments Sediments that form by the precipitation of minerals from water on Earth's surface. FIGURE 10.44 Sine waves combine to produce a composite wave. There are as many salts as there are
acids and bases. The rules above hold for ac or dc circuits. Cut a hole in the middle of the speaker. 2 3 The Sun is distorted by differential refraction. The advancing cold front wedges itself under the warm front so that the intersection between the two fronts is above ground. A refrigerator, typically rated at around
500 W, costs less for an hour, but much more over the course of a month. How does heat differ from thermal energy? Do this aloud to yourself (or to a friend), minimizing looking at the bottom of the "energy hill" of the curves shown in Figures 13.30, 13.31, and 13.32, so whether it undergoes fusion or fission, the product nuclei are
more massive than the iron. c 6. More than $100 billion was needed to repair storm damage and fund cleanup operations. Over time, these reactants form product molecules, and, as a result, the concentration of product molecules increases. What surface feature may we expect to find in a zone of normal faulting? For example, the present-day
Atlantic Ocean began as a tiny rift area between continental lands. EXPLAIN THIS T H E N AT U R E O F S CI E N CE LEARNING OBJECTIVE Discuss some similarities and differences among science, art, and religion. Show that the speed of sound in the vicinity of the fork is 340 m/s. 356 PA R T T W O CH E M I S T RY F I G U R E 1 4 .1 3 When
heated, orange ammonium dichromate undergoes a chemical change to ammonia, water vapor, and chromium(III) oxide. Would it be correct to say that the Doppler effect is the apparent change in the speed of a wave due to motion of the source? When 100°C water at atmospheric pressure is boiling, it is in thermal equilibrium. A classic example is
the mixing of ions (salt) in water. Obviously they are looking at different drops in the sky. What are sunspots? That's 50%. 692 PARTHREEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHREEARTHR
a skateboard.) 88. Now let's consider a larger system, enclosing both the orange and the apple. Fraction of Abundance 0.9889 Mass (amu) * 12.000 11.867 r step 1 YOU R TU RN Chlorine-35 has a mass of 34.97 amu, and chlorine-37 has a mass of 36.95 amu. Wastewater destined for a river requires the highest level of treatment for the benefit of
communities downstream. The spider's image is 30 cm in back of the mirror, so the distance from the image to your eye is 30 cm + 30 cm + 65 cm = 1.25 m. No "corners" form because they're simply pulled in. Consider a 100-kg box of tools in locations A, B, and C. Weight alone doesn't produce rotation. c, a, b, d. So a carbon dioxide
molecule is more than twice as heavy as a water molecule. (a) Table salt is generally a heterogeneous mixture of the compound sodium chloride plus desiccants that absorb moisture and prevent the salt from clumping. Diethyl ether, shown in Figure 19.15, was one of the first anesthetics. Chemical equation A representation of a chemical reaction in
which reactants are shown to the left of an arrow that points to the products. The resulting electric current in the wire can be attached to some Iron nail Cl \ge 2 \in E Fe El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 2 \in E Fe El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in the wire can be attached to some Iron nail El \ge 0 Repercise Current in th
OF CH EM I CALREACTIONS useful device, such as a lightbulb. The structures of these three aldehydes are shown in Figure 19.21. According to Einstein, gravity need not be viewed as a force exerted by one object on another through distance. The high altitude positions the satellite not beyond Earth's gravity, but beyond Earth's atmosphere
where air resistance is almost totally absent. This runoff must be collected by extensive drainage systems that combine curbs, storm sewers, and ditches to carry storm water runoff directly to stream channels. Where should she sit in order to balance, assuming the heavier boy remains in place? Are synthetic diamonds minerals? When he lifts the
exist at the end of any line or wherever two or more straight lines meet (unless another type of atom is drawn at the end of the line). When a cannon is fired, an interaction occurs between the cannon and the cannon are the end of the line).
common sense progressing beyond Aristotelian thinking. To combat wasteful habits, we often speak of "conserving energy," by which we mean turning off lights, heating or cooling systems, and hot water when not being used. The catalyst is typically platinum, Pt; palladium, Pd; or rhodium, Rd. CHECKPOINT How does a catalyst lower the activation
energy of a chemical reaction? it accelerates in a direction away from the sphere, and its electric potential energy changes to kinetic energy. The degree to which the light from the distant cluster bends is a function of the mass of the foreground cluster. Observe how well water conducts the sound. If the bulbs are connected in series in a circuit,
across which bulb is the greater voltage drop? Magnetic surveys of the ocean floor show alternating normal and reversed polarity, paralleling both sides of the rift area. Quantum hypothesis The idea that light energy is contained in discrete packets called quanta. A friend wonders what keeps the probe moving after the rocket no longer pushes it
Likewise, if one person began to pull harder, the ring would move away from the other two people. With a ballpoint pen write your name on a piece of paper on your desk. The fact that you can still hold the bottom shows that water 182 PA R T O N E P H Y S I CS is a poor conductor of heat. FIGURE 26.31 Geometry of a solar eclipse. For example,
both are motivated by curiosity for the natural. The faster the air molecules move, the greater their kinetic energy. Angular unconformity An unconformity in which older tilted rock layers are covered by younger, horizontal rock layers. Your weight in newtons? The fact that the Sun is compressed doesn't d2 change its mass, M, or its distance, d, from
Earth. I = V/R = (6 V)/(1000 \( \)) = 0.006 A. At the end of 10 s? This allows for the creation of many new stars, which is why most starburst galaxies in the process of colliding. Is this compound an alcohol or a phenol? SAM PLE PROBLEM 4 A student is told to use 20 g of sodium chloride to make an aqueous solution that has a concentration
of 10 g of sodium chloride per liter of solution. The returned signals revealed that the ocean floor was much more rugged than previously thought. The king soon saw that he could not fill this "modest" request, which amounted
to more wheat than had been T A B L E C. The water level remains the same when the ice melts. The chlorine allows the reaction to proceed in two steps, and the two smaller activation energies correspond to these steps. Transformer A device for transferring electric power from one coil of wire to another by means of electromagnetic induction.
Chlorine, for example, has three sets of paired electrons and one unpaired electrons and carbon has four unpaired electrons 8 Second period (three occupied shells) Neon Third period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons and one unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Second period (three occupied shells) 18 Unpaired electrons 8 Unpaired e
argon. In the second figure, the lever arm is equal to the length of the wrench handle. This is because these devices are connected not in series but in parallel with one another. Should we just accept it as a natural course of Earth's history? The farmer radiates more energy to the walls
than the walls radiate back at him, and he feels chilly. The nucleus and its protons are positively charged; electrons are negatively charged; electrons are negatively charged. Get a ceramic bowl and then, wearing safety glasses, grab a post-1982 penny with metal tongs or pliers and place that penny over a blue flame, such as from a Bunsen burner or a kitchen gas stove. See how
many nodes you can produce. We can separate this force into two components. Gaseous N2 Nonpolar molecules have only relatively weak attraction Nitrogen at 196°C Liquid N2 Nonpolar molecules have only relatively weak attraction Nitrogen at 196°C Liquid N2 Nonpolar molecules.
the steps in the collision- coalescence process: (a) cloud droplets form, (b) water vapor condenses on small particles, (c) cloud droplets are floated upward, (d) cloud droplets are bombarded by updraft droplets are floated upward, (d) cloud droplets are bombarded by updraft droplets form. A 5-kg fish swimming at 1 m/s swallows an absentminded 1-kg fish swimming toward it at a velocity that brings both fish
to a halt. Astrology has survived nearly unchanged since the second century AD, when some revisions were made by Egyptians and Greeks who believed that their gods moved heavenly bodies to influence the lives of people on Earth. Altitude. (d) quickly reaches zero. Positive. ** The ideal gas law is related to Boyle's law, which was discussed in
Chapter 5. Is it air, water vapor, or nothing? To how many atoms is a saturated carbon atom bonded? The cloud would have been very diffuse and large, with a diameter thousands of times larger than Pluto's orbit. The idea that momentum is conserved when no external force acts is elevated to a central law of mechanics, called the law of
                                   , which states: In the absence of an external force, the momentum of a system remains unchanged. In Chapter 1 we treated the weight of an object as the force due to gravity upon it. momentum, 75 Kuiper belt, 729 L Laminar flow, 604 Land subsidence, 597-598 Lateral continuity, rock dating and, 622 Lateral inhibition
269 Lava, 536-538 Law of acceleration, 41-46, 52 Law of conservation, 47-52 Law of conservation of momentum, 67-70 Law of conservation, 47-52 Law of mass conservation, 41-46, 52 Law of conservation, 41-46, 52 Law of mass conservation, 41-470 Law of mass conservation, 41-48, 52 Law of mass conservation, 41-46, 52 Law of conservation, 41-48, 52 Law of mass conservation, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48, 41-48
69 Laws of thermodynamics, 149-150 Leo-ger mnemonic, 471 Levers, 78 Lewis dot symbols, 368 Lifting condensation level, 689-690 Light, 264-292 color and, 275-281. But not so when air resistance slows the ball. A tornado acts like a gigantic vacuum cleaner, picking up everything in its path. A weightlifter who holds a barbell weighing 1000 N
overhead does no work on the barbell. (d) less momentum but more kinetic energy. What is the status of Pluto in the family of planets? As a child he showed no particular signs of brightness, and at age 1412 he was taken out of school to work on his mother's farm. Recall from Chapter 3 that a large change in momentum is associated with a large
impulse. 456 PARTTWOCHEMISTRY FIGURE 18.3 The hydronium ion's positive charge is a consequence of the extra proton this molecule has acquired. But if you move along with the electron. Put a small amount of water in an aluminum soft-
drink can, then heat the can on a stove until steam comes out of the opening. You also increase tion. A beta particle? The atmosphere, however, is not the only possible repository for the carbon dioxide we produce. (b) an outward spiral path. Would the listener hear an increase in the frequency of the horn if he were also in a car traveling at the same
speed in the same direction as you? Farther away, we find water-rich, low-temperature of the core of a star increases or decreases when iron and elements of higher atomic number than iron in the core are fused. In 1899, Friedrich Bayer and Company,
in Germany, introduced a chemically modified version of this compound in which the acidic phenolic group was transformed into an ester functional group. Two point charges each with 0.1 C of charge are 0.1 m apart. If friction is low and torque also low, the top tends to remain spinning. When a body of fresh water is partitioned from a body of salt
water by a semipermeable membrane, water molecules pass from the fresh water into Net flow of water molecules the fresh water into Net flow of water molecules pass from the salt water into Net flow of water molecules the fresh water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules the fresh water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water into Net flow of water molecules pass from the salt water molecules pass from 
prevented from pushing on the surface of the drink, as in the party-trick bottle with the straw through an airtight cork stopper, one can suck and get no drink. Uranium-238 has a half-life of 4.5 billion years. What is its electric charge? Diffuse Reflection In contrast to specular reflection is diffuse reflection, which occurs when light is incident
on a rough surface and reflected in many directions (Figure 11.14). Baker's yeast contains a biological catalyst known as catalase, which catalyzes the transformation of hydrogen peroxide, H2O2, into oxygen, O2, and water, H2O. The force that propels a rocket is provided by (a) gravity. Although two protons repel each other by the electric force,
they also attract each other by the strong nuclear force. So, any deposit of uranium ore will contain some lead that has been converted from uranium. Walking beside you, your friend takes 50 strides per minute while you take 48 strides per minute. The calculated value should therefore be somewhat greater. Willis/USGS 583: (left) REUTERS/Mainichi
Shimbun 583: (right) NOAA 589: Dean A. Suppose that at 11:58 A.M. some farsighted bacteria see that they are running out of space and launch a full-scale search for new bottles. In a parallel circuit, most current travels in the path of least resistance—but not all. The girl steadily pulls her end of the rope upward a distance of 0.4 m with a constant
force of 50 N. Although the bonds of both the N2 and O2 molecules are broken to form NO13 - , neither oxidation nor reduction occurs. The distribution of sunlight (Figure 11.31) is uneven, and the light is most intense in the yellow-green part of the spectrum. Astronomers measure the vast distances between Earth and the stars using light-years.
Molecular oxygen is a nonpolar covalent compound. The cost to the environment is also high (Figure 18.13). Discharge The volume of water that passes a given location in a stream channel in a certain amount of time. No work is done by gravity on a bowling ball resting or moving on a bowling alley because the force of gravity on the ball acts
perpendicular to the surface. So the reradiated energy remains in the car, which makes the car's interior even warmer (which is why leaving your pet in a car on a hot sunny day is a no-no). FIGURE 26.46 When the orbiting Earth intercepts the debris from a comet, we see a meteor shower. As the temperature of water is increased from 0°C, more of
the ice crystals collapse. What is the difference between a physical model and a conceptual model? Would this thermal equilibrium be possible if good absorbers were good emitters? During this period, he founded and developed the field of geometric optics, for which he first became famous. (c) both (d) neither
Answers to RAT 1. As a stream flows downhill and its gradient becomes gentler, the focus of its energy changes from eroding downward to eroding downward to eroding laterally in a side-to-side motion. FIGURE 5.35 Because of local fluctuations, the C H Ao
PTER18TWOCLASSESOFCHEMICALREACTIONS normal pH of rainwater varies between 5 and 7. FIGURE 3.6 In both cases, the impulse provided by the boxer's jaw reduces the momentum of the punch. At this rate there would be 263 grains of wheat on the 64th square. The methane of natural gas has the chemical property of
reacting with oxygen to produce carbon dioxide and water, along with appreciable heat energy. We state it generally in the following form: When heat flows to or from a system, the system gains or loses an amount of energy equal to the e
hold the nucleus together (Figure 13.13). This ability opened the field of nanotechnology, which we will discuss further in Section 14.7. CHECKPOINT Why are atoms invisible? Covalent bonds formed Oxygen atom O H O Hydrogen atom H H H Hydrogen atom Water molecule, H2O ammonia, NH3, shown in Figure 15.19. The Big Bang was not like a
firecracker that someone would have been able to watch explode. Good question. If you drop an object, its acceleration toward the ground is 10 m/s2. Project what human civilization would be like if our Sun were hidden in a dusty part of the galaxy such that no stars were ever visible to us at night. (a) A high-formula-mass alcohol is too attracted to
itself to be soluble in water. Assume the total number of molecules in a sample of liquid is about 3 million trillion. FIGURE16.16 When the molecule-to-molecule attractions among solvent molecules are A sucrose molecule contains many comparable to the molecule attractions among solvent molecules, hydrogen-oxygen covalent
bonds, in which the hydrogen atoms are there is no practical point of saturation. When you squeeze the bulb, air rushes across the open end of a tube inserted into the perfume. In the next chapter, however, we will explore in greater detail the nature of the atomic nucleus, which is a potential source of enormous amounts of energy. Scientists have
experimented with ways of enhancing the ocean's ability to absorb atmospheric carbon dioxide. This organic salt is as different from hydrogen chloride as is sodium." Think of it this way: Assume you have a cousin named George. What component of hard water
makes it hard? Big Bang The primordial explosion of space at the beginning of time. What is an advantage of using chlorine gas to disinfect drinking water supplies? Is this best described as a physical or a chemical change? The disodium salt of ethylenediaminetetraacetic acid, also known as EDTA, has a great affinity for lead ions, Pb2 + . West? With
their polarization axes at right angles to each other? The water is then filtered through sand and gravel. These two forms of matter differ significantly in that when ordinary matter collides with matter—a piece of lead about 8 light-years
thick would be needed to stop half the neutrinos produced in typical nuclear decays. Permitted energy levels are a natural consequence of electron waves closing in on themselves in a synchronized manner. A 2-molar (2 M) solution contains 2 moles of solute per liter of solution. A ship therefore floats higher in salt water than in F I G U R E 5 .1 5 The
weight of a floating object equals the weight of the water displaced by the submerged part. If the bug bobs in the water at a constant frequency, the distance between wave crests (the wavelength) is the same in all directions. You ordinarily pour water from a full glass into an empty glass simply by placing the full glass above the empty glass and
tipping. FIGURE 21.2 Diagram of a seismograph. Predict. A more promising longrange source of energy is found on the left side of the energy valley. The fact that this jumbling doesn't occur is evidence that sounds of all frequencies travel at the same speed. +6 +2 +6 B 65. Smaller chunks of asteroids are sent hurling toward Earth much
more frequently than larger chunks of asteroids. So, in units form, Watts = amperes * volts The relationship between energy and power is a magnetic field about moving protons as well. It is a pseudoscience lying within the realm of superstition. More important, the
field stores energy. So when a car traveling twice as fast crashes, it crashes with four times the energy. A photon of light is emitted. The magnetic fields. Your advice is sought. To measure out equal numbers of carbon atoms and oxygen molecules
we could measure out 12 g of carbon and 32 g of molecular oxygen. So the speed at the top is equal to the horizontal component of the ball's velocity at any point. FYI + - FIGURE 3.34 When electric current passes through conducting water, bubbles of hydrogen form at one wire and bubbles of oxygen form at the other. Its time in the air is t, and it
reaches a maximum height h. Galileo recognized that the small difference is due to friction with the air (air resistance) and this difference wouldn't be present if there were no friction. Are we difference wouldn't be present if there were no friction. Are we difference wouldn't be present if there were no friction with the air (air resistance) and this difference wouldn't be present if there were no friction. Are we difference wouldn't be present if there were no friction with the air (air resistance) and this difference wouldn't be present if there were no friction with the air (air resistance) and this difference wouldn't be present if there were no friction with the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and this difference wouldn't be present if the air (air resistance) and the air (air resistance) are the air (air resistance) and the air (air resistance) are the air (air r
rapidly boiling water? Basalt is a volcanic rock. What is the long-range fate of all the uranium that exists in the world today? The recipient of the hydrogen ion is H2O, which is behaving as a base as it transforms to H3O + . 27.3 The Hertzsprung-Russell Diagram EXPLAIN THIS W When is a cool star larger than a hot star? When the screen is lit, some
of the spots are red, some are green, and some are green, and some are blue; the mixtures of these primary colors at a distance provide a complete range of colors, plus white. Each scale reads 350 N. When all is said and done, the liquid magma freezes to become rock. A corrosive chemical has the power to disintegrate a material or wear away its surface. LEARNING
OBJECTIVE Use the periodic table to predict the type of ion an atom tends to form. Because air is a poor conductor, very little energy travels sideways to your fingers. FIGURE 2 1.19 Normal polarity Reversed polarity As new material is extruded at an oceanic ridge (spreading center), it is magnetized according to the existing magnetic field. This
form is repeated over and over in three dimensions. Why are your answers different? A 12-kg piece of metal displaces 2 L of water when submerged. According to Bayer, Hoffman was inspired by his father, who had been complaining about salicylic acid's side effects. On the way to becoming lead, it exists as a series of elements, as indicated in Figure
13.17. When used as in Figure 3.30, it changes only the direction of the force; but, when used as in Figure 3.31, the output force is doubled. A water barometer would have to be 13.6 * 0.76 m, or 10.3 m high—too tall to be practical. Primary Secondary ac input FIGURE 9.31 A simple transformer. Compression A condensed region of the medium
through which a longitudinal wave travels. The closeness between us is in our hearts. 1 Density 5. Breathing through a hose that extends to the surface can't occur because air will not move from low pressure at the surface to higher pressure below in your lungs. Bottles 1, 2, 3, and 4 are all full double twice (22 = 4; quadruple) in size; in three
doubling times, its size will increase eightfold (23 = 8); in four doubling times, it will increase sixteenfold (24 = 16); and so on. For a galaxy such as the Milky Way or Andromeda, it sure looks as though most of the mass is concentrated within the central bulge. Why may an ideal Polaroid filter transmit anything from zero to 100% of incident polarized
light? 340 PA R T T W O CH E M I S T RY FIGURE 13.31 Nucleon in a uranium nucleus has more mass of each nucleon in any one of its nucleon in any one of its nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in any one of its nucleon in a uranium nucleus is greater than the mass of each nucleon in any one of its nucleon in any one of its nucleon in a uranium nucleus is greater than the mass of each nucleon in any one of its nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in any one of its nucleon in any one of its nucleon in any one of its nucleon in a uranium nucleus is greater than the mass of each nucleon in any one of its nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon in a uranium nucleus is greater than the mass of each nucleon 
investing in nuclear energy? Furthermore, Venus spins in a direction opposite to the direction of Earth's spin. To summarize, a rising air parcel cools at the dry adiabatic lapse rate until it reaches saturation. (Guess who is credited with discovering this?) The law applies also to warming. Examine the three-dimensional geometries of PF5 and SF4
shown below. FIGURING PHYSICAL SCIENCE Silica Enrichment in Magma Magma becomes enriched in silica, SiO2, as crystals such as olivine grow within it. Marchers at the band to reach the marchers at the back. 14.4 Determining Physical
and Chemical Changes 16. Quite impressive! 35. What produces a magnetic field? This acceleration is not sensed at all. What does inorganic mean in the definition of a mineral? One or more electrons from each metal atom are free to move throughout the atomic lattice. Because the Martian atmosphere has a very low density, its winds are about 10
times as fast as winds on Earth. d A B e FIGURE 2.20 Which falls toward the other: planet B? Oxygen, O2. Upon which is the gravitational force greater: a 1-kg piece of iron or a 1-kg piece of glass? This makes the lone pair in NF3 less available to attack the positive charge on another molecule. Consider the swinging-balls apparatus. How
is the direction of an electric field defined? Repulsive electric interactions, on the other hand, are relatively long-ranged. Recall, from Section 15.8, that chemical bonds are generally many times stronger than molecule-to-molecule
attractions. The intense pressure from the weight of Earth above crushes atoms together so tightly that even high temperature cannot budge them. The cycle reverses during the following two weeks, as we see less and less of the sunlit side while the Moon continues in its orbit. (b) alternating current. A gold ring that is 50% pure is 12 karat. Cells at
the top of a tree have a higher concentration of sugars than cells at the bottom. Bouncing If a flowerpot falls from a shelf onto your head, you may be in trouble. Iron smelters operating in China, for example, release pollutants that are readily detected in Seattle, Washington. What happens to the concentration of a solution made with such a solvent as
the temperature of the solution is increased? Unfortunately, as the molten metal cools and shrinks, it also pulls away from the inside of the mold while it is still soft, which means that it doesn't retain the form of the mold very well. 1. Then use the same method for the solution to the preceding problem and show that the resistance of the hair dryer is
12 \(\frac{1}{4}\). What two mineral groups provide most of the ore that society needs? Galileo reasoned that a ball moving horizontally would move forever if friction were entirely absent. Rank these stages of stellar development from earliest to latest: (a) white dwarf, (b) nova, and (c) red giant. Which heteroatom is characteristic of an amine? The buoyant force
is equal to the weight of the water displaced. Room-temperature water boils spontaneously in a vacuum—on the Moon, for example. (c) Zero, since no skidding occurs. VEC TORS We can better understand the motion of the boat by resolving the force of wind impact, F, into perpendicular components. A surfer, in a similar way,
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