Physical Science Answer Key

Chapter 1 The Nature of Physical Science

SECTION 1 SCIENCE AND SCIENTISTS

1. asking a question
2. She can ask her teacher, look in books or magazines, check the Internet, or ask an expert.
3. research, observation, experimentation
4. Keep a record of the wind direction before a storm. Check a weather map in the newspaper or on the Internet.
5. airbags and seat belts
6. Between 1990 and 2000 was the biggest gain—almost 14%.
7. They can warn people when bad storms are coming.
8. rocks, minerals, and soil
9. wildlife management, farming, forestry, resource protection
10. skills in art and science

Review

1. research, observation, and experimentation
2. books, Internet, scientific journals, experts
3. Draws diagrams of body parts—science illustrator; studies volcanic eruptions—volcanologist; knows how to remove oil from the ground—geochemist; measures wind speed of hurricanes—meteorologist; knows how plants and animals affect one another—ecologist
4. Answers will vary. They may include: cure people of diseases; warn people of hurricanes, tornadoes, or earthquakes; find out what's causing bad environmental changes; and design and test safety equipment.
5. Answers will vary. They may include: Ask the restaurant manager, use the Internet to find out how much salt is usually added to fries, and observe the cook who prepares the fries.
6. 3 m/day × 30 days = 90 m

SECTION 2 SCIENTIFIC METHODS

1. ways in which scientists answer questions and solve problems
2. drawing conclusions
3. scientists who build things based on scientific knowledge
4. as flippers
5. a possible explanation or answer to a question
6. less; same
7. controlled parameters
8. a placebo
9. foils or flipperlike paddles
10. The boat went the same distance under the same weather conditions.
11. the flapping rate of the foils
12. to interpret what the data mean
13. 1.7 flaps per second
14. *Proteus*; 17% more efficient
15. Their results supported their hypothesis.
16. Write a paper, give a talk, create a Web site.

Review

1.

Steps in Scientific Methods
Ask questions.
Form a hypothesis.
Make observations.
Test hypothesis.
Analyze results.
Draw conclusions.

2. to answer questions and solve problems
3. guess and explanation
4. The results from the control group are compared with the results from the experimental group to see if the hypothesis was correct.
5. The variable parameter is the only factor in the experiment that is different for the experimental group.
6. The variable parameter in the mouse experiment was the drug. The variable parameter in the *Proteus* experiment was the flapping rate of the foils.

SECTION 3 SAFETY IN SCIENCE

1. chemicals, heat sources, animals, plants
2. Goggles should be circled.
3. not following directions
4. Bunsen burners and other heat sources
5. Gases can get trapped under the lenses and harm your eyes.

6. Hot plate and chemicals in beakers, cylinders, or test tubes should be circled.
7. First-aid kit, fire extinguisher, fire blanket, and eye bath should be circled.
8. emergency care for someone hurt or sick
9. goggles, apron, gloves

Review

1. Read all the directions before beginning the lab.
2. Follow directions; keep work place neat; wear protective clothing; clean up after lab; use equipment and chemicals carefully.
3. Answers will vary: eye bath, first-aid kit, fire blanket, fire extinguisher, protective clothing, goggles, gloves
4. Place my hand in cold water for 15 minutes.
5. from first row, left to right: eye protection, clothing protection, hand safety,heating safety, electrical safety, chemical safety, animal safety, sharp objects, plant safety

Chapter 2 Data in Science

SECTION 1 TOOLS AND MODELS IN SCIENCE

1. computers, calculators, and graph paper
2. time, mass, length, volume, temperature
3. It changes how big the unit is.
4. one-tenth or 0.1; 0.1 g
5. A metric ton is 1,000 greater than a kilogram.
6. 150 mm
7. kelvin, K
8. The difference is 100 on both scales.
9. cubic meter, m^3
10. the amount of matter in a given volume
11. miles per hour or kilometers per hour
12. Yes, 2.5 m/s is accurate; it is the correct speed.

    No, the measurements are not the same.
13. They use very complicated calculations.
14. organize and test information
15. the bottom part
16. The marble shot by a slingshot would use a law, and the car on a race track would use a theory.

Review

1. $D = m \div V$
2. Density: $D = m \div V$

   Volume: $V = l \times w \times h$

   Speed: $s = d \div t$
3. The data must show reproducibility, or precision. The density must be accurate, or correct, for the liquid.
4. Possible answer: If everyone uses the same units, it is easy to follow the same process. Using different units can add inaccuracy during conversions.
5. 4,000 m/h

SECTION 2 ORGANIZING YOUR DATA

1. the variables from an experiment
2. The experimenter chooses to change or control the independent variable; this causes the dependent variable to change.
3. The information is not useful unless you know what it represents.
4. If more than one parameter is variable, you cannot determine which causes a change in the dependent variable.
5. x-axis
6. the variable on that axis and its units
7. range
8. 50 hours
9. increased
10. As the weeks increase, the number of hours exercised increases.
11. the direction of the curve

Review

1. so that the relationship between them can be determined
2. Inverse linear relationship: Line should be straight and should run from top left to bottom right.

   Direct nonlinear relationship: Line should not be straight and should run from bottom left to top right.
3. In order to determine whether there is a relationship, you must change one variable and measure the effect on another variable.
4. A change in the independent variable does not cause a change in the dependent variable.
5. Independent variable is hours of light; dependent variable is plant height.

SECTION 3 ANALYZING YOUR DATA

1. Even if scientists don't speak the same language, they all understand the same math.

2. 65 mL
3. The meter stick would be less accurate because you can introduce errors every time you move it as you cross the gym.
4. median
5. 9, 8
6. 52
7. the change in y values; the change in x values
8. The value of y decreases.
9. The density is the slope of the line, and the slope of the line has only one value.

Review

1. Mean is $(12 + 10 + 6 + 9 + 6 + 7 + 6) \div 7 = 8$; median is 9; mode is 6.
2. Slope is rise over run on a linear graph.

   Median is the middle value of a data set arranged least to greatest.

   Mode is the data value that occurs most often in a data set.

   Mean is the average value of a data set.
3. The slope of the line is zero, so a change in number of seed types has no effect on the number of birds at the feeder.
4. The slope will give the speed of the car, in meters per second.
5. The data are not accurate. The density is larger than the known value.

Chapter 3 Properties of Matter

SECTION 1 WHAT IS MATTER

1. volume: liter

   mass: kilogram

   weight: newton
2. the amount of space that an object takes up
3. 1,900 mL
4. the curved surface of a liquid in a container
5. The line should curve downward from the 7 mL line to the 6 mL line and back to the 7 mL line.
6. volume
7. area
8. 1 m^2
9. Possible answer: Put the car into a known volume of water in a graduated cylinder. Measure how much the volume increases.
10. the amount of matter in it
11. weight
12. none, change
13. kilograms, grams, milligrams
14. newton (N)

Review

1. An apple has a mass and takes up space.
2. Mass is a measure of how much matter is in an object. Weight is a measure of the force due to gravity on an object.
3. 19 mL
4. 40 mL
5. $V = A \times h$; $V = 1{,}960\ cm^2 \times 23\ cm = 45{,}080\ cm^3$ No, the luggage is too big.

SECTION 2 PHYSICAL PROPERTIES

1. properties that can be observed and measured without making a new substance
2. its mass or weight, its density, its compressibility
3. the amount of matter in a given space
4. 15 times as much, or 43 more grams
5. $D = m \div V$

   $D = 28\ g \div 1.45\ cm^3$

   $= 19.3\ g/cm^3$
6. at the same temperature and pressure
7. zinc
8. when it is denser than water
9. The diet soda; it floats.
10. it has the smallest density
11. a change that affects the physical properties of a substance
12. melting
13. a change of state
14. A gas can change into a liquid or into a solid.
15. nothing

Review

1. Divide the mass of the substance by its volume.
2. No, because all the substances are more dense than methanol.
3. aluminum
4. The ball with the smaller volume has the larger density.
5. Its volume must increase.

SECTION 3 CHEMICAL PROPERTIES

1. change into new matter

2. They are different.
3. The identity of the substance does not change when the physical property is observed; when the chemical property is observed, the substance changes identity.
4. It is gasoline; its flash point separates it from kerosene.
5. a change that produces a new substance
6. its bad smell
7. The cake has properties that are different from its ingredients.
8. color change, change in texture, odor given off, heat absorbed or released
9. A new substance has not been made.

Review

1. A chemical property of a substance describes the chemical change that can happen to it.
2. You can observe a physical property without changing the substance. You can observe reactivity only when a substance reacts and becomes a different substance.
3. heat
4. Chemical: rusting
   Physical: boiling
   Physical: freezing
   Chemical: burning
5. a color change, a change in texture, an odor given off, heat absorbed or produced
6. Chemical change; a color change indicates that a chemical change has taken place.
7. A chemical change caused the heat; a chemical change caused the smoke; a physical change caused the wax to melt.

Chapter 4 States of Matter

SECTION 1 FOUR STATES OF MATTER

1. solid, liquid, gas, plasma
2. They move about the most in the gas state and the least in the solid state.
3. They are close together and have a strong attraction for one another. They are locked in place.
4. move past one another
5. The shape of the liquid changes, but the volume stays the same.
6. The particles move faster and farther apart.
7. in the balloon
8. Electrons are ripped from the particles of the gas. This forms ions and free electrons.

Review

1. Matter is made of very small particles called atoms and molecules.
2. solid—brick, penny, ice cube; liquid—water, milk, soda, oil; gas—air, oxygen, water vapor; plasma—sun, star, lightning, neon sign
3. The particles of a liquid can move past one another. The particles of a solid stay in fixed positions.
4. The particles of a gas can move far away from one another. The particles of a liquid stay close to one another.
5. Solid: yes, yes, atoms, molecules
   Liquid: no, yes, atoms, molecules
   Gas: no, no, atoms, molecules
   Plasma: no, no, ions, electrons

SECTION 2 CHANGES OF STATE

1. energy
2. It changes into a gas or evaporates or vaporizes, then condenses.
3. physical change, or change of state from solid to liquid
4. flow, or move past one another
5. 68°C
6. The sweat removes energy from your body as it evaporates.
7. 100°C; 0°C
8. above a beaker of water at its boiling point
9. Water from a lake evaporates, then condenses to become part of a cloud.
10. evaporation
11. The warmer temperatures cause the water droplets to evaporate.
12. It changes directly from a solid into a gas.
13. The graph is horizontal, or flat. This means that the temperature is constant.

Review

1. The particles of a solid only vibrate. The particles of a liquid can move past one another. The particles of a gas are free to move anywhere.

2. Energy is added or removed during a change of state. The identity of matter does not change, so changes of state are physical changes.
3. Melting requires the input of energy; freezing requires the removal of energy. Their similarity is that they both happen at the same temperature.
4. Both processes change a liquid to a gas. Evaporation is a slower process than boiling. In an open container, you need to heat a liquid in order to boil it.
5. Sublimation requires energy and changes a solid directly to a gas.
6.

Property	Solid	Liquid	Gas
Attraction between particles	strong	weaker than in a solid	little or none
How close the particles are	close	close	far apart
Movement of particles	vibration only	movement past one another	freedom of movement

Chapter 5 Elements, Compounds, and Mixtures

SECTION 1 ELEMENTS

1. Elements cannot be separated into simpler substances.
2. the meteorite
3. hardness, melting point, density
4. Because their properties are so similar to iron's properties, cobalt and nickel can be used where a strong metal is needed, such as in structures, tools, and vehicles.
5. These properties are too similar in the two elements to be used to tell them apart.
6. small size; short, curly hair; shape of face
7. metals, nonmetals, metalloids

Review

1. Metals are good heat conductors; nonmetals are poor heat conductors.
2. Copper is metal; oxygen is nonmetal; silicon is metalloid.
3. Possible answers: Yes, because metals conduct electric current, and nonmetals don't. Yes, because electric wires are made of copper or aluminum, which are metals. No, because some metalloids conduct electric current, so some of the wires may be metalloids.
4. The elements are nonmetals. The elements must be clear gases if they are used between window panes, and all of the elements that are gases are nonmetals. In addition, metals conduct heat, not block it.
5. $100\% - (92.7\% + 6.9\%) = 0.4\%$

SECTION 2 COMPOUNDS

1. a pure substance composed of two or more elements that are combined chemically
2. The properties can be very different from those of its elements.
3. Room temperature is about 25°C. This value falls between the melting point and the boiling point of all three compounds.
4. sodium
5. It's safe to eat.
6. by measuring or observing its unique set of properties
7. It fizzes when mixed with vinegar.
8. heat

Review

1. The basic particles of a compound contain atoms of more than one element. The basic particles of an element are the atoms of that element.
2. from top to bottom: compounds; unique properties; elements; heat or electricity; physical; chemical
3. There was a chemical reaction with something in the air that formed a new compound with different properties.
4. The air forms a new compound with iron, but nitrogen does not. Because they have different chemical properties, air and nitrogen are not identical.

SECTION 3 MIXTURES

1. physical change
2. The chemicals in the mixtures are not changed into new chemicals.
3. A pure substance has the same particles throughout, so it cannot separate into layers.

4. with a burner or hot plate
5. the water
6. The ratio of components in a mixture is not fixed, but a compound always has the same elements in the same ratio.
7. solvent
8. water
9. It is not a solution because the metals are not distributed evenly throughout the coin.
10. Oxygen, carbon dioxide, alcohol, salt, and zinc should be circled.
11. mass of solute and volume of solution
12. You add more than the solubility of sugar in water.
13. 160 g per 100 mL of water

Review

1. The solvent is ethanol; the solute is sucrose.
2. from top to bottom: mixture; solution; solvent; solute
3. Iron is a solid. It has to be melted to make a liquid so that the other elements can be distributed evenly in it. When the iron-carbon-nickel solution cools, it becomes steel, a solid solution.
4. The solubility of sugar is lower in cold water than in hot water, so some of the sugar came out of solution.

Chapter 6 Introduction to Atoms

SECTION 1 DEVELOPMENT OF THE ATOMIC THEORY

1. An atom is the smallest particle of an element that keeps its properties.
2. According to Dalton's theory, atoms of different elements are different.
3. when experiments provide data that do not fit the original theory
4. positive
5. negative
6. Atoms are electrically neutral, so there must be a positive charge to balance the negative charge of the electrons.
7. electrons
8. a beam of small, positively charged particles
9. Most particles followed a straight path.
10. outside the nucleus
11. about 19 mi
12. the head of the pin
13. 1) Electrons move around the nucleus in definite paths.

    2) Electrons cannot exist between energy levels.

    3) Electrons can jump from one energy level to another.
14. The nucleus is the center circle. The nine smaller circles are electrons.
15. Electron clouds are regions where electrons are likely to be found.
16.

Bohr model of the atom	Modern model of the atom
Electrons are tiny particles with a negative charge.	Electrons are tiny particles with a negative charge.
Electrons are located outside the nucleus.	Electrons are located outside the nucleus.
Electrons orbit the nucleus in specific paths.	Electrons are found in electron clouds; they occupy energy levels.

17. Atoms of an element are different from atoms of every other element.
18. more than 200,000 atoms thick

Review

1. The electron cloud is about 100,000 times as large as the nucleus of the atom.
2. Dalton: Each element is made of a different type of atom.

    Thomson: Atoms have negative particles called electrons.

    Rutherford: The positive part of the atom, the nucleus, is small and dense.

    Bohr: Electrons are found in specific energy levels.

    Modern scientists: You cannot predict exactly where an electron is or what path it will take.
3. Atoms are electrically neutral, so if they contain negative particles, they must also contain positive particles to balance the charge.
4. discovery of new facts about atoms that are not consistent with the modern atomic theory
5. Thomson: electrons scattered throughout the atom

    Bohr: electrons found in energy levels

    Dalton: hard sphere that can't be broken apart

    Rutherford: atom with a nucleus

SECTION 2 THE ATOM

1. protons, neutrons, electrons
2. clockwise from top left: electrons, protons, neutrons
3. Protons and neutrons are in the nucleus; electrons surround the nucleus.
4. atomic mass unit, or amu
5.

Particle	Charge	Mass (amu)
Proton	1+	1
Neutron	0	1
Electron	1–	$\frac{1}{1,840}$

6. the number of protons in the nucleus and the number of electrons around the nucleus
7.

Element	Hydrogen	Helium
Number of protons	1	2
Number of neutrons	0	2
Number of electrons	1	2
Atomic number	1	2

8. Neutrons allow protons to stay close together.
9. Its nucleus would break apart because the protons repel one another.
10. They have different numbers of neutrons.
11. The number of neutrons does not affect the chemical properties of oxygen.
12. No; the mass number is the atomic number plus the number of neutrons, so it can never be smaller than the atomic number.
13. 6 protons and 7 neutrons
14. 1
15. The atom changes into an atom of a different element because there is one more proton in the nucleus.
16. gravitational force, electromagnetic force, strong force, weak force

Review

1. All atoms of an element have the same number of protons, so they have the same atomic number. Isotopes have different numbers of neutrons, so they have different mass numbers.
2.

Particle	Charge	Mass (amu)
Proton	1+	1
Neutron	0	1
Electron	1–	$\frac{1}{1,840}$

3. The electromagnetic repulsion of the protons would cause the nucleus to break apart without neutrons.
4.

Atom	Atomic #	# Protons	# Neutrons
C-14	6	6	8
N-14	7	7	7

Chapter 7 The Periodic Table

SECTION 1 ARRANGING THE ELEMENTS

1. He found a pattern in the properties of the elements.
2. X should be placed between silicon and sulfur; Y should be placed between carbon and oxygen.
3. 3
4. 2.6 amu higher than predicted
5. Mendeleev sorted elements by atomic mass. Now, they are sorted by atomic number.
6. 7 periods; 18 groups
7. The number of metals is much larger than the number of nonmetals.
8. Metals are shiny, malleable, ductile, and good conductors of electric current and heat.
9. Nonmetals have nearly full outer energy levels, but metals have only one or two electrons in their outer energy levels.
10. “Brittle” or “very brittle” should be circled.
11. an abbreviation using one or two letters of the element’s name
12. name, symbol, atomic number, atomic mass
13. Rn, Xe, Kr, Ar, Ne, or He
14. an element with a temporary name
15. 14, 14, 86, 86, 92, 92

Review

1. two elements in the same group

2. Left-hand side and center of the periodic table—metal; right-hand side of the periodic table—nonmetal; near the zig-zag line toward the right-hand side of the periodic table—metalloid
3. The properties of rubidium are more like those of cesium. They are both in Group 1, but strontium is in Group 2.
4. PbS is lead and sulfur; KBr is potassium and bromine; RaO is radium and oxygen.
5. Sodium is a metal; krypton is a nonmetal; phosphorus is a nonmetal.

SECTION 2 GROUPING THE ELEMENTS

1. They have the same number of electrons in the outer energy level, so they react in similar ways.
2. lithium-3, sodium-11, potassium-19, rubidium-17, cesium-55, francium-87
3. They need to lose two electrons instead of the one electron that alkali metals lose.
4. 112
5. mercury
6. 5, 13, 31, 49, 81, 113
7. It is a lightweight, strong metal.
8. carbon
9. N and P
10. Sulfur is a brittle, yellow solid.
11. Fluorine is 9, chlorine is 17, bromine is 35, iodine is 53, astatine is 65.
12. Compounds have been made by reacting Group 18 elements and other elements.
13. In the current model, noble gases have a filled outer energy level, so the theory predicts they would not be reactive. This agrees with observations.
14. Although it loses one electron, like the alkali metals, it has properties more like the nonmetals.
15. The number of protons determines the element of an atom. All of the possible elements smaller than uranium already exist.

Review

1. Both groups are one electron removed from having a stable, full outer electron shell. Alkali metals need to lose one electron; halogens need to gain one electron.
2. Periodic table organizes elements into
   [left-hand side] groups of very reactive metals: alkali metals, very reactive nonmetals: halogens, unreactive elements: noble gases
   [right-hand side] classes: metals, nonmetals, metalloids
3. Because they are so unreactive, there was no way to detect the noble gases chemically.
4. All of the nonmetals have outer energy levels that are at least half filled, so they don't tend to lose electrons easily.

Chapter 8 Chemical Bonding

SECTION 1 ELECTRONS AND CHEMICAL BONDING

1. Atoms gain, lose, or share electrons.
2. in energy levels outside the nucleus
3. in the outermost energy level
4. 6 protons, 6 electrons
5. The label goes on the central part of the atom.
6. six
7. to get a full outermost energy level
8. lose

Review

1. Atoms bond by losing electrons to other atoms, gaining electrons from other atoms, or sharing electrons with other atoms.
2. two dots on inner circle; seven red dots on outer circle
3. The easiest way for an atom with seven valence electrons to complete its outermost level is to gain one electron from another atom (but it may share electrons).
4. The Mg atom can give its two valence electrons to the O atom.
5. 16, 16

SECTION 2 IONIC BONDS

1. An ionic bond forms when valence electrons are transferred from one atom to another.
2. Ions are atoms that have gained or lost electrons. Atoms are neutral, while ions have a positive or negative charge.
3. The attraction between the electron and the protons has to be broken.
4. 2+
5. nonmetals
6. energy

7. 0 on the left and 2– on the right
8. because positive ions are attracted to negative ions
9. sodium fluoride
10. Salt's properties are completely different from the properties of sodium and chlorine.
11. crystal lattice

Review

1. Magnesium loses its two electrons to a nonmetal atom. It becomes a positive ion with a charge of 2+.
2. Arrows should point from the two electrons in the outermost level of the magnesium atom to the outermost level of the sulfur atom.
3. Potassium will become a positive ion because it will lose an electron. Fluorine will become a negative ion because it will gain an electron.
4. crystal lattice

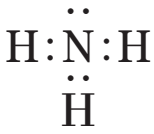
SECTION 3 COVALENT AND METALLIC BONDS

1. Electrons are shared in covalent bonds; they are not gained or lost.
2. covalent
3. H·
4. H:H
5. diatomic
6. chlorine—eight; oxygen—eight; nitrogen—eight
7. chlorine—one pair; oxygen—two pairs; nitrogen—three pairs
8. three covalent bonds
9. four
10. It is formed by the attraction between positively charged metal ions and the electrons around the ions.
11. The electrons can move throughout the metal.
12. Valence electrons are free to move throughout the wire.
13. Ductility means being able to be shaped into long, thin wires. Malleability means being able to be hammered into sheets.

Review

1.

Forms covalent bonds	Forms metallic bonds
oxygen	gold
carbon	aluminum
fluorine	copper

2. 

3. You would use substances with covalent bonds as insulation. You would use a metal to conduct heat.
4. The properties of oxygen change; water does not have the same properties as oxygen.
5. Metals can conduct electricity, can be stretched into wires, and can be hammered into thin sheets.

Chapter 9 Chemical Reactions

SECTION 1 FORMING NEW SUBSTANCES

1. a process in which one or more substances react to produce one or more new substances
2. formation of gas, formation of solid, change in color
3. The chemical properties of the new substances are different from those of the original substances.
4. They are broken and formed.
5. The bonds in the hydrogen and chlorine molecules are broken. The bonds in the hydrogen chloride molecule form.
6. Energy is either given off or absorbed by chemical reactions.
7. The temperature probably decreased because the reaction absorbed heat energy from the surroundings.
8. Energy cannot be created or destroyed; it can only change forms.

Review

1. Exothermic reactions give off energy. Endothermic reactions take in energy.
2. Energy is released when a chemical bond forms. Energy is consumed when a chemical bond breaks.
3. exothermic—fire; endothermic—photosynthesis

4. When water boils, the chemical bonds in the water molecules do not break, and no new bonds form. Therefore, water boiling is not a chemical reaction.
5. The chemical properties of the material in the beaker are different from those of the original substances. This shows that a chemical reaction must have occurred.

SECTION 2 CHEMICAL FORMULAS AND EQUATIONS

1. the elements found in a substance and how many atoms of each element are in a molecule
2. three
3. dihydrogen sulfide
4. $SiCl_4$
5. 3+
6. a short way to show what happens in a chemical reaction using symbols and formulas
7. Reactants are C and O_2; product is CO_2.
8. If you use the wrong chemical formula, a chemical equation will not describe the correct reaction.
9. The total number and kinds of atoms before and after a reaction must be the same. You can count atoms in the reactants and products to determine if the chemical equation is balanced.
10. Step 2: H = 2, O = 2, H = 4, O = 2
    Step 3: H = 4, O = 2, H = 4, O = 2

Review

1. A chemical formula represents a molecule. A chemical equation represents a chemical reaction.
2.

Chemical equation	Number of atoms in the reactants	Number of atoms in the products	Is the equation balanced?
$Na + Cl_2 \rightarrow NaCl$	Na = 1 Cl = 2	Na = 1 Cl = 1	no
$HCl + NaOH \rightarrow NaCl + H_2O$	H = 2 Cl = 1 Na = 1 O = 1	H = 2 Cl = 1 Na = 1 O = 1	yes
$2Sb + 3I_2 \rightarrow 2SbI_3$	Sb = 2 I = 6	Sb = 2 I = 6	yes

3. silicon dioxide; antimony triiodide
4. Changing the subscripts changes the meaning of the chemical formula. Therefore, if you change subscripts, you change the chemical reaction that you are describing.
5. They are the same.

Chapter 10 Chemical Compounds

SECTION 1 IONIC AND COVALENT COMPOUNDS

1. what happens to the valence electrons
2. Metals form positively charged ions, and nonmetals form negatively charged ions.
3. A crystal lattice is a pattern. Each ion in the pattern bonds to the ions around it that have the opposite charge.
4. They have strong bonds that hold the ions together.
5. They conduct an electric current because their ions are now free to move past each other.
6. Solid sodium chloride will not conduct an electric current. Sodium metal will conduct an electric current.
7. They contain molecules that are not attracted by water molecules.
8. No ions are formed when it dissolves in water.

Review

1. Ionic compounds have a much higher melting point than covalent compounds.
2. from top to bottom: covalent, covalent, ionic, ionic
3. Ionic compounds break apart easily because they bond together in a pattern called a crystal lattice. If you hit an ionic compound, the ions move and the pattern changes. Ions that have the same charge line up and repel each other.
4. When the crystals dissolve in water, ions become free to move.
5. Atoms of the metal each lose one or more electrons to the atoms of the nonmetal. The metal atoms form positive ions, and the nonmetal atoms form negative ions. The oppositely charged ions attract, forming ionic bonds.

SECTION 2 ACIDS AND BASES

1. A hydrogen ion bonds with a water molecule to form the hydronium ion.
2. sour taste
3. An indicator is something that changes color in the presence of an acid or base.
4. Litmus and bromthymol blue are two indicators.

5. hydrogen gas and zinc chloride
6. ions
7. making fertilizers
8. orange juice, vinegar, soft drinks
9. It neutralizes the excess acid.
10. Hydroxide ions give bases their properties.
11. It could hurt you because chemicals such as acids and bases can be corrosive or poisonous.
12. blue
13. household cleaners and fertilizers

Review

1 Acids have hydronium H_3O^+ ions, and bases have hydroxide (OH^-) ions. When acids and bases meet, they cancel each other out. The solution becomes neutral.

2.

Property	Acids	Bases
Taste	sour	bitter
Color change of litmus paper	red	blue
Reacts with metals to produce hydrogen gas	yes	no
Electrical conductivity	yes	yes

3. hydronium
4. No, because acids and bases both conduct electricity.
5. It turns blue because ammonia is a base.
6. The acid or base is corrosive.
7. Base; rinse them with a lot of water and tell the teacher.

SECTION 3 SOLUTIONS OF ACIDS AND BASES

1. The amount of acid or base dissolved in water.
2. A strong acid has more molecules that break apart when it is dissolved in water than a weak acid does.
3. water and a salt
4. pH is a measure of the hydronium ions in a solution.
5. Bases have high pH value, and acids have low pH.
6. Use pH paper or a pH meter.
7. when a positive ion from a base combines with a negative ion from an acid
8. table salt and melting snow and ice

Review

1. In water, all the molecules of a strong acid break apart and form hydrogen ions. When a weak base is dissolved in water, only a few molecules break off to form hydroxide ions.
2. When an acid and base combine, there is a neutralization reaction. The hydrogen ions from the acid combine with the hydroxide ions from the base to form water and a salt.
3. sodium hydroxide + hydrochloric acid → water + sodium chloride
   (or $NaOH + HCl \rightarrow H_2O + NaCl$)
3. with pH paper or a pH meter
4. The pH would be around 9 because bases have high pH values. The stronger the base is, the higher the number is.
5. If the pH value is low, that indicates acid. The lower the number is, the more acidic it is. This would be a bad place for fish to live, because the water would be too acidic.

Chapter 11 The Chemistry of Living Things

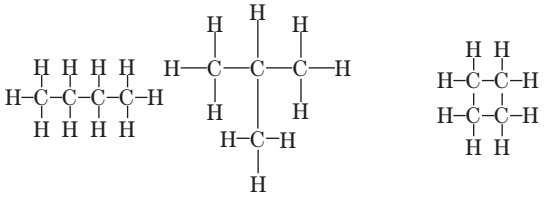
SECTION 1 ELEMENTS IN LIVING THINGS

1. Answers will vary. Their work should show that they multiplied 0.185 by their body weights.
2. Other elements, such as iron, calcium, sodium, and potassium, make up the other 2.4%.
3. a compound in which carbon is covalently bonded to other carbons and to other types of atoms
4. four
5. straight chain, branched chain, and ring
6. two, or a pair
7. 4, or two pair
8. single, double, or triple bonds
9. four
10. three
11. two

Review

1. The six most common elements found in organic compounds are, in descending order, oxygen, carbon, hydrogen, nitrogen, phosphorus, and sulfur.

2. Carbon is an element capable of making bonds with other carbon atoms or atoms of other elements. Carbon has four valence electrons that can form four bonds. (All living things contain organic compounds.)

3. 

4. Organic compounds found in nature are derived from living things, so petroleum must come from living things, or things that were once living.
5. Answers will vary and may include vitamins, antibiotics, pain medicines such as aspirin, and synthetic oils for use as energy alternatives.
6. Carbon atoms can form double bonds by sharing two pairs of electrons; they can also form triple bonds by sharing three pairs of electrons.

SECTION 2 COMPOUNDS OF LIVING THINGS

1. about nine pounds
2. Water helps control body temperature, makes joints move easily, cushions delicate organs, transports nutrients, helps make the molecules we use for energy, and helps get rid of body wastes.
3. Your body needs salt in order to conduct electrical signals.
4. carbohydrates, proteins, lipids, and nucleic acids
5. two
6. a long chain of repeating units
7. These vitamins are fat-soluble, so extra amounts are not washed out by water, as happens with water-soluble vitamins.
8. Proteins are made of amino acids.
9. hemoglobin
10. sugars, phosphates, and nucleotides
11. adenine
12. how to organize amino acids to make proteins

Review

1. Water surrounds all your joints, bones, and delicate organs such as eyeballs and brain. The water absorbs shock that comes with everyday use of your body.
2. water—small molecule; carbohydrates—small and large molecules; proteins—large molecules; salts—small molecules; nucleic acids—large molecules; lipids—large molecules
3. polymer
4. energy

Chapter 12 Matter in Motion

SECTION 1 MEASURING MOTION

1. It must appear to stay in one place.
2. the mountain
3. Owen's desk
4. one positive unit on the y-axis and one positive unit on the x-axis, or one positive unit on the x-axis and one positive unit on the y-axis
5. Average speed is the total distance divided by the total time. Sometimes the bird flies faster, and sometimes it flies more slowly.
6. $average\ speed = \frac{total\ distance}{total\ time}$

   $average\ speed = \frac{10\ \text{m}}{2.5\ \text{s}} = 4\text{m/s}$
7. a straight, diagonal line from the point 0, 0 to the point 10 s, 7 m
8. No; velocity needs a direction as well as a speed.
9. raindrop falling faster and faster: <u>speed</u>
   baseball hit by a batter: <u>speed and direction</u>
   <u>variable answers</u>: speed and direction
10. Yes; his speed is increasing.
11. It slows down.
12. positive, negative

Review

1. Speed is the rate at which an object moves, but velocity is the rate at which an object moves in a particular direction.
2. in the following order: at rest, positive acceleration, constant velocity, deceleration
3. The skateboard starts at rest and speeds up for 15 s. It stops for 5 s. It speeds up for 10 s. Then turns around and speeds back to its starting point.
4. $average\ speed = \frac{total\ distance\ traveled}{total\ time}$

   $average\ speed = \frac{80\ \text{m}}{40\ \text{s}} = 2\text{m/s}$

SECTION 2 WHAT IS A FORCE

1. direction and magnitude, or size
2. The forces are balanced.
3. Arrow pointing right is the size of both small arrows combined.
4. 125 N of pushing and 120 N of pulling
5. The rope would not move. The forces would be balanced.
6. Down arrow should be labeled "compression," other arrows "tension."
7. The weight of the feeder is balanced by the tension in the wire.
8. Gravity exerts an unbalanced force on the arrow, pulling it down.
9. Put an unbalanced force on it.
10. The magnitude of the force backward must be greater than the magnitude of the force forward.

Review

1. Net force is the total force acting on an object. If all of the forces balance each other out, there is no net force.
2. from top to bottom: compression, tension
3. from left to right: 10 N to the right; 13 N down
4. The object on the left will move or accelerate to the right. The object on the right will move or accelerate down.
5. Answers may vary; student should explain that an object under compression is being pushed or squeezed.

SECTION 3 FRICTION: A FORCE THAT OPPOSES MOTION

1. Friction is a force that opposes the motion between two surfaces that touch.
2. In many cases, the hills and valleys are very tiny.
3. Friction produces an unbalanced force on the object, which causes the object to slow down.
4. when the force that is applied to the object causes the object to move
5. A lubricant makes the surfaces smoother by filling up the valleys and smoothing down the hills.
6. to reduce friction and make the bike chain move more smoothly
7. Pressing harder increases the force between the pan and the scrubber. This increases the friction between their surfaces.

Review

1. Friction makes it harder to get objects moving and keep them moving.
2. Static friction is friction between two surfaces that are not moving. Kinetic friction is between moving surfaces. Possible examples: Friction between the floor and a refrigerator that is being pushed but is not moving is static friction. Friction between rolling bike tires and a road is an example of kinetic friction.
3. Sketch should show smoother surfaces; peaks and valleys have less relief.
4. Grease, oil, and wax are lubricants. They smooth the surfaces so that there is less friction between surfaces that touch.
5. Friction always acts in the direction opposite the direction of motion.
6. The car would not stop. Friction between the brake pads and the wheels causes the wheels to stop turning. Friction between the wheels and the road causes the car to slow down.

Chapter 13 Forces and Motion

SECTION 1 GRAVITY: A FORCE OF ATTRACTION

1. force of attraction between objects due to their masses
2. Their masses are small, so they don't have much gravity.
3. because of the gravitational pull between Earth and the moon
4. masses of objects, distance between objects
5. Gravitational force is greater between objects with large masses.
6. mass and distance
7. As the distance between two objects increases, the gravitational force decreases. As the distance between two objects decreases, the gravitational force increases.
8. Mass is the amount of matter in an object, but weight is the amount of gravitational force on an object.
9. 1,588 N on Earth; 271 N on the moon
10. Gravity pulls down, and the shelf pushes up.

Review

1. Gravity is a force of attraction between objects. It is influenced by the masses of objects and the distance between them.
2. It will get larger.
3. The astronaut has the same mass on Earth and on the moon, but the astronaut has a greater weight on Earth than on the moon. This is because the gravitational force is less on the moon than on Earth because the moon has less mass than the Earth.
4. 80 kg; 1,568 N
5. The first pair should be circled. The reason is that the spheres are the largest pair of masses separated by the smallest distance.

SECTION 2 GRAVITY AND MOTION

1. Aristotle believed that the rate of an object's fall depends on its mass, and Galileo believed that objects fall at the same rate.
2. Two golf ball images should be drawn along the same line as the ping pong ball images.
3. Acceleration depends on force and mass. A heavier object is harder to accelerate but also experiences a greater gravitational force.
4. 9.8 m/s faster; the smaller velocity subtracted from the larger one
5. v_{final} = final velocity; g = acceleration due to gravity; t = time
6. gravity and air resistance
7. The crumpled paper has a greater net force acting on it.
8. Terminal velocity is the velocity when the net force is 0 N. The object has stopped accelerating because the force of air resistance is equal to the force of gravity.
9. a place where there is no matter
10. They will both hit at the same time because they have the same acceleration.
11. horizontal and vertical movement
12. gravity
13. It stays constant.
14. The path should curve down and toward the target.
15. forward motion and free fall
16. It would fall to Earth.
17. keeps an object moving in a circular path
18. Gravity provides a centripetal force that keeps the planets in orbit.
19. Pluto

Review

1. The brick experiences a greater gravitational force than the sponge, but the brick is also harder to accelerate because it has a greater mass than the sponge. The extra mass of the brick makes up for the additional gravitational force.
2. free fall—gravity; falling at terminal velocity—gravity and air resistance; arrow traveling at a target—gravity (air resistance is ignored); satellite orbiting Earth—gravity or centripetal force (air resistance is ignored)
3. Air resistance opposes the motion of objects through the air. Air resistance decreases the downward acceleration of a falling object.
4. Centripetal force keeps objects in circular motion. The sun supplies the centripetal force that keeps planets in orbit.

SECTION 3 NEWTON'S LAWS OF MOTION

1. They are the same size.
2. It will not change speed or direction.
3. The distances would be greater.
4. Apply an unbalanced force in the direction opposite to its motion.
5. Friction slows it down.
6. The car has a lot of inertia. It is difficult to push hard enough to get it to move.
7. The golf ball has less mass and less inertia.
8. the pickup truck
9. The cart with the greater mass (the full cart) will accelerate less than the empty cart.
10. If a larger force is exerted on a full cart, then it will increase in acceleration.
11. Object B pushes on object A with an equal force but in the opposite direction.
12. Action force is the down arrow; reaction force is the up arrow.
13. They are the same size.
14. Action force points straight down; reaction force points straight up; arrows should be the same length.
15. Earth is much bigger than the object, so its acceleration is very small.

Review

1. The object may speed up, slow down, or change its direction of motion.
2. from left to right: force, friction, acceleration, inertia

3. Increase the force on the object. Decrease the mass of the object.
4. The motion will not change. An object at rest will stay at rest. An object with a constant velocity will continue moving at constant velocity.
5. Without friction, the ball would continue to roll at the same speed, assuming the surface stayed level.
6. The action force is the push of my foot on the ball. The reaction force is the ball pushing back on my foot.

Chapter 14 Forces in Fluids

SECTION 1 FLUIDS AND PRESSURE

1. any material that can flow and that can take the shape of its container
2. the force exerted on a given area
3. $pressure = \frac{force}{area}$

   $pressure = \frac{3{,}000\ \text{N}}{2\ \text{m}^2}$

   $pressure = 1{,}500\ \text{Pa}$
4. The arrows would still be the same length. The pressure inside still must equal atmospheric pressure.
5. It decreases.
6. about $\frac{1}{2}$
7. The weight of the entire atmosphere is pushing down.
8. The weight of more and more fluid is pushing on the same area.
9. about 100 kPa
10. When you suck on the straw, you suck air out of it. Since there is less air in the straw, the air pressure is lower.
11. The pressure inside the lungs is greater than the pressure outside.

Review

1. The particles of the fluid hit the walls of the container. The force exerted causes pressure.
2. Density is the mass of a substance divided by its volume. Materials that are more dense will exert more pressure than materials that are less dense.
3. $pressure = \frac{force}{area}$

   $pressure = \frac{2.5\ \text{N}}{0.012\ \text{m}^2}$

   $pressure = 208\ \text{Pa}$
4. Clockwise from top left:

   A muscle in your chest contracts. The volume of your chest gets larger.

   Air pressure inside your chest is lower than atmospheric pressure.

   The muscle in your chest relaxes. The volume of your chest gets smaller.

   Air pressure inside your chest is higher than atmospheric pressure.

SECTION 2 BUOYANCY AND DENSITY

1. Fluid pressure increases with depth.
2. differences in pressure
3. 3.6 N
4. They are the same.
5. float
6. more
7. Its weight is equal to the buoyant force of the water it displaces.
8. the mass of an object divided by its volume
9. If it is denser than water, it will sink. If it is less dense than water, it will float.
10. Greater; air is more dense than helium, so the same volume has a greater mass.
11. $density = \frac{mass}{volume}$

    $density = 180\ \text{g} \div 10\ \text{cm}^3$

    $density = 18\ \text{g/cm}^3$
12. It is difficult to measure the dimensions of the object, so you cannot calculate its volume using an equation.
13. The volume of the ship is much larger than the volume of the steel used to make it.
14. If the shape increases the volume, the object's density will be less.
15. by letting water into its ballast tanks
16. by letting gases into or releasing them from the swim bladder

Review

1. When the force is removed, the wood will pop back up to the surface because the buoyant force is greater than the weight of the wood block.

2. $Density = \frac{mass}{volume}$

   $Density = 4{,}810\ g \div 355\ mL$

   $Density = 13.5\ g/mL$

3. Its volume or mass can change.
4. If the object's density is greater than the density of the fluid, the object will sink in the fluid. If the object's density is the same as or less than the density of the fluid, the object will float.

Chapter 15 Stars, Galaxies, and the Universe

SECTION 1 STARS

1. Candle flame should be yellow; Bunsen burner flame should be blue.
2. the candle flame
3. They study the light from stars.
4. No, the light we see is very old. We may see light from stars that no longer exist.
5. From left to right, emission lines should be colored purple, blue, green, and red.
6. A
7. B
8. −1.4
9. 1.8
10. Circle should be around the light that is smallest and closest to the bottom of the photo (farthest away); box should be around the largest (closest) light, the first from the left.
11. The dimmest lights are farthest away.
12. 283.8 trillion km
13. Earth's revolution around the sun
14. The Earth's rotation makes it seem as if they are moving.
15. Arrow should go counterclockwise.

Review

1. hydrogen and helium
2. Distances are very large, so it is easier to use a large measurement such as light-years.
3. The stars seem to move because the Earth is rotating.
4. Apparent magnitude is the brightness of a star as seen from Earth. Absolute magnitude is the brightness of a star as seen from 32.6 light-years from Earth.
5. The stars are too far away. They also move very slowly over thousands of years.
6. Color: Class B are blue-white and Class K are orange. Temperature: Class B are 10,000–30,000°C and Class K are 3,500–5,000°C. Composition: Class B are made of H and He; Class K are made of Ca and Fe.

SECTION 2 THE LIFE CYCLE OF STARS

1. They can look at different stars at different life stages.
2. white dwarf
3. temperature and brightness
4. at the top
5. at the far left
6. The brightness and temperature of the star change with age.
7. Polaris
8. No, it has become a red giant.
9. a supernova, or giant explosion
10. No, a neutron star is caused by a supernova. Only massive stars explode in a supernova.

Review

1. protostar, main-sequence star, red giant, white dwarf
2. horizontal axis—spectral type; vertical axis—absolute magnitude
3. From the main sequence to a red giant, the star becomes cooler. From a red giant to a white dwarf, the star becomes hotter.
4. After its main sequence, an average star becomes a red giant. After its main sequence, a massive star may become a neutron star, pulsar, or black hole.

SECTION 3 GALAXIES

1. They measure the size and brightness of the galaxy.
2. in the bright bulge in the center
3. A spiral galaxy has arms, and an elliptical galaxy does not. Spiral galaxies have many new stars, and elliptical galaxies do not.
4. gas, dust, and stars
5. They absorb light.
6. Nebulas are where stars are born. Star clusters have stars that were born in nebulas.

Review

1. A nebula is a part of a galaxy. It is where stars are formed. A galaxy is a group of many stars, dust, and gas.

2. spiral, elliptical, and irregular

3.

Galaxy feature	What they are made of	Where they are found	Other
Nebula	gas and dust	all through a galaxy	Stars are born there.
Open cluster	100 to 1,000 stars, relatively close together	on the body of a spiral galaxy	It may have bright blue stars.
Globular cluster	up to 1 million stars, packed close together	around a spiral galaxy or near a large elliptical galaxy	It looks like a ball.

4. New stars form from gas and dust. Dust and gas are found in the spiral arms
5. Sketch could like a disk with a bulge in the middle (if seen from the side) or like a spiral (if seen from above).

SECTION 4 FORMATION OF THE UNIVERSE

1. expanding
2. Temperature decreased.
3. They were squeezed into one very small volume.
4. expansion of the universe and cosmic background radiation
5. There are more planets; each galaxy can have many planets.
6. galaxy cluster, galaxy, planetary system, planet
7. about 14 billion years

Review

1. If the universe is expanding, then the contents of the universe must have originally been squeezed into one small volume. From that small volume, the universe exploded and expanded.
2. It is energy left over from the big bang explosion.
3. Planets make up planetary systems. Planetary systems make up galaxies. Galaxies make up galaxy clusters.
4. I would study the oldest stars in the Milky Way to find their age. Since it took 1 billion years for the first white dwarfs to form, the universe must be 1 billion years older than the oldest white dwarf.
5. Some scientists think the universe will expand faster and faster. If the universe continues to expand, the stars will die and the universe will be cold and dark.

Chapter 16 Our Solar System

SECTION 1 A SOLAR SYSTEM IS BORN

1. a mixture of gases and dust
2. The particles are small and far apart, so they do not attract one another very strongly.
3. collisions between the particles of the nebula
4. The pressure that balances gravity is caused by collisions of moving particles.
5. the nebula that became our solar system
6. Gravity affects the collapse more because it is stronger than pressure.
7. the center
8. gravity
9. spherical
10. join together
11. core, radiative zone, chromosphere, corona
12. $(3.0 \times 10^8\ \text{m/s})^2 = 9.0 \times 10^{16}\ \text{m}^2/\text{s}^2$
13. gravity
14. helium
15. It has one proton.
16. deuterium, helium-3, helium-4
17. 2 AU
18. Neptune

Review

1. Gravity causes particles to move toward one another. Pressure causes particles to move away from one another.
2. Core—hot center of sun where energy is produced; radiative zone—very dense region surrounding the core, about 300,000 km thick; convective zone—region where gases circulate, about 200,000 km thick; photosphere—the part of the sun that we can see from Earth; chromosphere—thin region below the corona, about 30,000 km thick; corona—outer atmosphere of the sun
3. Gravity pulls all of the particles toward the center. A sphere is the shape in which particles are closest together.
4. Astronomical unit (AU) is 150,000,000 km, or the distance from Earth to the sun.
5. Light-year equals about 9,500,000,000,000 km.

SECTION 2 THE INNER PLANETS

1. They have a makeup similar to Earth.
2. Mercury is much closer to the sun than any other planet.
3. density
4. The rotations are in opposite directions when viewed from above the North Pole.
5. One day is longer than one year on Venus.
6. The thick atmosphere prevents visual observations, even from space probes.
7. its oceans
8. The period of revolution is 6 h longer than 365 days; 4×6 h $= 24$ h, or 1 day.
9. Mars has a thinner atmosphere, and it is farther from the sun.
10. A Martian day is 37 minutes longer than an Earth day.
11. erosion and sediments
12. at the poles, and possibly below the surface
13. evidence that water once existed on the Martian surface

Review

1. It is rotation in the opposite direction.
2. Mercury: 0.38 AU, 58 days, 19 h
   Venus: 0.72 AU, 243 days, 16 h
   Earth: 1.00 AU, 365 days, 6 h
   Mars: 1.52 AU, 1 year, 322 days
3. Features on the surface show that there may have been erosion or sedimentation that is similar to that caused on Earth by water. For water to exist as a liquid, the surface would have to be warmer and the atmosphere thicker than they are currently.
4. The planets with low surface gravity, Mercury and Mars, have very thin atmospheres, while Venus and Earth have thicker atmospheres. The higher gravity exerts a greater pull on the gas particles, keeping them closer to the planet.
5. The density of Earth is higher than that of Venus, so its mass is greater. Since they have about the same diameter, the more massive planet will have the greater surface gravity.

SECTION 3 THE OUTER PLANETS

1. Its period of rotation is only 9 h, 55.5 min.
2. The Earth revolves around the sun about 29 times while Saturn goes around once.
3. water, ice, and dust
4. The force of gravity depends on mass and distance. The distance from the surface to the center is farther for Saturn than for Earth.
5. hydrogen
6. A year on Uranus lasts almost 84 Earth years.
7. North Pole and South Pole
8. Its gravity affected the orbit of Uranus.
9. Neptune is just over 30 times as far from the sun as Earth.
10. The farther a planet is from the sun, the longer its year.
11. in the solar system, beyond Pluto

Review

1. hydrogen
2. Jupiter: 5.20 AU, 11 Earth years, 313 days
   Saturn: 9.54 AU, 29 Earth years, 155 days
   Uranus: 19.21 AU, 83 Earth years, 273 days
   Neptune: 30.06 AU, 163 Earth years, 263 days
   Pluto: 39.5 AU, 248 Earth years, 4 days
3. The farther a planet is from the sun, the longer the length of a year is and the lower the surface temperature is.
4. They are made of only gases. They are larger than the inner planets. The gas giants are farther from the sun. The length of a year is longer. They receive less energy from the sun than the inner planets.
5. its small size, composition, and irregular orbit

SECTION 4 MOONS

1. They have studied rocks from the moon brought back by Apollo astronauts.
2. They are craters formed by impacts with other objects.
3. the composition of rock from the moon
4. the force of gravity
5. Light from the sun is reflected from the moon's surface to Earth.
6. The moon changes its position in relation to the sun and Earth.
7. the right-hand side of the figure
8. The moon is between the sun and Earth.
9. The moon's shadow covers only a small part of Earth.
10. The moon's orbit is tilted slightly in relation to Earth's orbit around the sun.
11. gas giant
12. Deimos, Phobos

13. Ganymede, Callisto, Io, Europa
14. liquid water
15. No, there is no oxygen, or not enough, for people to breathe.
16. They may have been captured by Uranus's gravity.
17. Planets revolve around the sun. Moons revolve around planets.

Review

1. full moon
2. from left to right, top to bottom: satellite, artificial, natural, moon, moons, Galilean moons (or name of one, Phobos or Deimos)
3. The moon was formed early in the history of the solar system and has not changed much, because there is no erosion. The solar system is about the same age as the oldest rocks on the moon.
4. Yes. The most massive planets, the gas giants, have the most moons because their gravitational pull is so strong that they can capture other bodies that come near them.

SECTION 5 SMALL BODIES IN THE SOLAR SYSTEM

1. ice, rock, and dust
2. Arrow should be toward the upper left-hand corner of the figure.
3. far beyond the orbit of Pluto
4. The ion tail is pushed away from the sun by the solar wind.
5. The comet can be seen only when it is close enough to the sun to have tails that reflect sunlight.
6. between Mars and Jupiter
7. It is too small for the force of gravity to pull it into a spherical shape.
8. Asteroids are much smaller.
9. a small asteroid
10. A meteoroid is a particle of dust or debris in space. A meteorite is a meteoroid that reaches Earth's surface.
11. stony, metallic, stony-iron
12. iron and nickel

Review

1. A comet leaves a trail of debris including small rocks called meteoroids. When the meteoroids enter Earth's atmosphere, they become hot and glow as meteors.
2. asteroid: large chunks of rock or metal, much smaller than planets; asteroid belt, between Mars and Jupiter

   comet: mostly ice with pieces of rock, Oort cloud and Kuiper belt

   meteoroid: small chunks of rock or metal, throughout the solar system
3. These objects are made up of material that has not changed during the life of the solar system. They give scientists information about the material that formed the planets.
4. Comets start at the outer parts of the solar system, come close to the sun, and then travel back to distant parts of the system. Most asteroids orbit in the region between Mars and Jupiter.
5. so that people can have enough time to try to change its course and avoid a collision that would cause a catastrophe