Physical Science
Concept Review Worksheets with Answer Keys

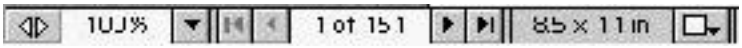
To jump to a location in this book

1. Click a bookmark on the left.

To print a part of the book

1. Click the Print button.
2. When the Print window opens, type in a range of pages to print.

   The page numbers are displayed in the bar at the bottom of the document. In the example below, “1 of 151” means that the current page is page 1 in a file of 151 pages.



Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: The Nature of Science

1. **Name** four branches of biological science.

2. **Define** the following terms:
   a. science

   b. technology

   c. scientific model

3. **Describe** the difference between a scientific law and a scientific theory.

4. **Explain** why it is important for scientists to be objective in their observations.

5. **Explain** why each of the following steps is important to scientific study.
   a. planning experiments

   b. testing results

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: The Way Science Works

1. Name three tools used by scientists, and describe how they are used.

_____

_____

_____

2. Explain why an experiment should test only one variable at a time.

_____

_____

_____

3. Convert the following measurements as indicated:

_____ **a.** 95 cm to meters

_____ **b.** 1.1 L to milliliters

_____ **c.** 17 000 m to kilometers

_____ **d.** 500 kg to grams

_____ **e.** 2.55 mmol to moles

4. Explain why it is important that a hypothesis be stated so that it can be modified.

_____

_____

_____

5. Describe why prefixes are useful with SI units.

_____

_____

_____

6. Explain why scientists use SI units instead of units such as inches and gallons.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Organizing Data

1. Convert the following measurements from scientific notation to long form:

_____ **a.** 2.54×10^{-3} cm

_____ **b.** 9.5×10^{4} km

_____ **c.** 3.3×10^{-1} L

_____ **d.** 7.445×10^{2} g

2. Convert the following measurements to scientific notation:

_____ **a.** 325 kg

_____ **b.** 0.000 46 m

_____ **c.** 7104 km

_____ **d.** 0.0028 L

3. Find the number of significant digits in each of the following:

_____ **a.** 0.003 26

_____ **b.** 39 010

_____ **c.** 77 900.1

_____ **d.** 1.5300

4. Identify the type of graph best suited to display the following:

a. the amount of iron ore in four different countries

_____

b. the major gases found in Earth's atmosphere

_____

c. the price of crude oil since 1990

_____

5. Explain how results can be precise but not accurate.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: What Is Matter?

1. Classify the following as a homogeneous, *O*, or a heterogeneous, *E*, mixture.

_____ **a.** a pail of sand and water

_____ **b.** air

_____ **c.** human blood

_____ **d.** banana split

_____ **e.** chocolate syrup

_____ **f.** sea water

2. Compare and contrast atoms and molecules.

_____

_____

3. Explain the difference between a pure substance and a homogeneous mixture.

_____

_____

_____

4. Classify each of the following as an element or a compound.

_____ **a.** benzene, C_6H_6

_____ **b.** aluminum, Al

_____ **c.** aspirin, $C_9H_8O_4$

_____ **d.** titanium,Ti

_____ **e.** acetylene, C_2H_2

_____ **f.** zinc, Zn

5. Explain why elements and compounds are pure substances.

_____

_____

_____

6. Determine which of the following are pure substances and which are mixtures.

_____ **a.** salt water

_____ **b.** isopropyl alcohol, C_3H_8O

_____ **c.** mercury, Hg

_____ **d.** ammonia, NH_3

_____ **e.** an egg yolk

_____ **f.** honey

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Properties of Matter

1. Classify each of the following as a physical or chemical property of sulfur.

_____ **a.** Its density is 2.97 g/cm^3.

_____ **b.** It reacts with hydrogen to form a gas.

_____ **c.** It is a yellow solid.

_____ **d.** Its melting point is 112°C.

_____ **e.** It combines with oxygen.

2. Classify each of the following as a physical or chemical property of phosphorus.

_____ **a.** It is a white, waxy solid.

_____ **b.** It burns in air.

_____ **c.** Its melting point is 44.1°C.

_____ **d.** It has a density of 1.82 g/cm^3.

_____ **e.** Its boiling point is 280.3°C.

3. Explain how aluminum is a suitable material to use in making cans based on its physical and chemical properties.

_____

_____

_____

4. Calculate the mass of a sample of pure silver (density = 10.49 g/cm^3) that has a volume of 12.99 cm^3.

_____

_____

5. Compute the density of an 820 g sample of pure silicon occupying a 350 cm^3 container.

_____

_____

6. Describe how the characteristic properties of a piece of ice are different from its other properties.

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Changes of Matter

1. **Categorize** each of the following examples as a chemical or physical change.

_____ **a.** bending a metal rod

_____ **b.** burning wood

_____ **c.** breaking glass

_____ **d.** painting wood

_____ **e.** cooking

_____ **f.** burning propane

2. **Explain** why dissolving is a physical change.

3. **Explain** why baking is a chemical change.

4. **Compare** physical changes and chemical changes.

5. **List** 4 ways to detect that a chemical change has occurred.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Matter and Energy

1. Identify each of the following as a gas, liquid, solid, or plasma.

_____ **a.** The particles are closely packed together, but they can still slide past each other.

_____ **b.** The particles are in a constant state of motion and rarely stick together.

_____ **c.** The particles are locked in fixed positions.

_____ **d.** The particles are broken apart.

2. Select the answer that best completes each statement describing the energy transfers taking place as water changes state from solid to liquid, from liquid to gas, and from gas back to liquid.

a. Energy must be added/released (choose one) to separate the water molecules as ice melts.

b. The fastest/slowest (choose one) moving molecules break away from the surface of liquid water to form water vapor.

c. The process described in (b) is called _____.

d. During the above process, energy is released/absorbed (choose one).

e. Water molecules speed up/slow down (choose one) as water vapor returns to the liquid water state.

f. The process described in (e) is called _____.

g. Energy is released/absorbed (choose one) during the above process.

3. Apply the kinetic theory to describe the motion of particles in a homogeneous mixture of sugar and water as it is boiled.

_____

_____

_____

_____

4. Explain how mass and energy are conserved when water evaporates.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Fluids

1. **Explain** how Archimedes' principle determines the buoyant force on an object in any fluid medium.

2. **Compare** the buoyant force of water and the weight of a piece of wood that floats on the water.

3. **Calculate** the pressure of an enclosed fluid on which a force of 150 N is exerted over an area of 10 cm^2. Give the answer in pascals.

4. **Explain** Pascal's principle.

5. **Calculate** the force output by the larger piston of a hydraulic lift when a force of 700 N is exerted on the smaller piston. The areas of the two pistons are 20 cm^2 and 950 cm^2.

6. **Define** Bernoulli's principle.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Behavior of Gases

1. Identify which gas law is being demonstrated.

_____ **a.** increase in volume, decrease in pressure

_____ **b.** decrease in temperature, decrease in volume

_____ **c.** increase in pressure, increase in temperature

2. Compare and contrast the physical properties of solids, liquids, and gases.

_____

_____

_____

_____

_____

_____ **3.** Boyle's law relates the pressure of a gas to the _____ of a gas.

a. volume
b. pressure
c. density
d. temperature

_____ **4.** Charles' law relates the volume of a gas to the _____ of a gas.

a. mass
b. density
c. temperature
d. molecules

_____ **5.** Gay-Lussac's law relates the temperature of a gas to its

a. mass.
b. volume.
c. density.
d. pressure.

6. Explain what must happen to a fixed sample of gas when its temperature changes.

_____

_____

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Atomic Structure

1. **Draw** and label the parts of a helium atom. Include the mass and charge of each subatomic particle.

2. **Describe** the three main ideas of Dalton's atomic theory in your own words.

3. **Compare** the outermost electrons of an atom with the inner electrons of an atom in terms of energy.

4. **Compare** the positions of the electrons in Bohr's model of the atom with their positions according to modern atomic theory.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: A Guided Tour of the Periodic Table

1. **Write** the chemical symbol for each of the following elements:

   _____ **a.** manganese

   _____ **b.** lead

   _____ **c.** carbon

   _____ **d.** uranium

   _____ **e.** radon

   _____ **f.** silver

2. **State** the importance of valence electrons in the organization of the periodic table.

3. **Describe** the difference between the atomic number and the mass number of an atom.

4. **Understanding Systems** Why do atoms of Group 1 elements lose electrons to form cations, whereas atoms of Group 17 elements gain electrons to form anions?

5. **Create** a chart that shows the different isotopes of hydrogen. State the name of each isotope, and write the number of protons, neutrons, and electrons found in each isotope.

6. **Explain** how the relative abundance of each hydrogen isotope affects hydrogen's average atomic mass.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Families of Elements

1. Classify each of the following elements as an alkali metal, alkaline-earth metal, transition metal, or semiconductor based on its position in the periodic table.

_____ **a.** rubidium, Rb

_____ **b.** silicon, Si

_____ **c.** silver, Ag

_____ **d.** barium, Ba

2. Classify each of the following elements as a halogen, noble gas, or other nonmetal based on its position in the periodic table.

_____ **a.** carbon, C

_____ **b.** chlorine, Cl

_____ **c.** radon, Rn

_____ **d.** phosphorus, P

3. Predict which of the following ions would be likely to form:

_____ **a.** Na^{2+}

_____ **b.** Cl^{+}

_____ **c.** Ca^{2+}

_____ **d.** Br^{-}

_____ **e.** Ne^{-}

_____ **f.** Ne^{+}

4. Explain why chlorine, Cl, is very reactive, whereas argon, Ar, is unreactive.

_____

_____

_____

5. Analyze the following pairs of elements, and determine whether each pair has similar or different reactivities.

_____ **a.** potassium, K, and rubidium, Rb

_____ **b.** calcium, Ca, and barium, Ba

_____ **c.** sodium, Na, and chlorine, Cl

_____ **d.** helium, He, and krypton, Kr

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Using Moles to Count Atoms

1. Define a *mole*.

_____

_____

_____

2. Identify which of the following statements are correct:

_____ **a.** 1 mol of titanium, Ti, is 47.88 g

_____ **b.** 1 mol of strontium, Sr, is 40.08 g

_____ **c.** 2 mol of carbon, C, are 24.02 g

_____ **d.** 1 mol of mercury, Hg, is 200.6 g

3. Explain why the mole is used as a counting unit for atoms.

_____

_____

_____

4. Determine the molar mass of each of the following elements:

_____ **a.** calcium, Ca

_____ **b.** cobalt, Co

_____ **c.** sulfur, S

_____ **d.** oxygen, O

5. Outline the steps required to find the mass in grams of an element from a given amount of the element in moles.

_____

_____

_____

_____

6. Determine the mass in grams of each of the following:

_____ **a.** 0.60 mol of neon, Ne

_____ **b.** 5.01 mol of xenon, Xe

_____ **c.** 1.9 mol of selenium, Se

_____ **d.** 3.3 mol of gold, Au

7. Determine the amount in moles of each of the following:

_____ **a.** 0.35 g of hydrogen, H

_____ **b.** 405 g of boron, B

_____ **c.** 26 g of chromium, Cr

_____ **d.** 8.5 g of sulfur, S

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Compounds and Molecules

1. **Explain** why it is more difficult to separate the elements of a compound than the substances in a mixture.

_____

_____

2. **Write** the numbers and kinds of atoms or ions contained in the following compounds:

_____ **a.** NaCl

_____ **b.** CO_2

_____ **c.** KBr

_____ **d.** NH_3

_____ **e.** MgO

3. **Describe** the difference between a ball-and-stick model and a space-filling model of a compound.

_____

_____

_____

4. **Explain** why a substance with a network structure has a high melting point.

_____

_____

_____

5. **Contrast** the structure of table salt and table sugar.

_____

_____

_____

_____

6. **Predict** whether a compound with a boiling point of 68°C is likely to be a network solid or in the form of individual molecules.

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Ionic and Covalent Bonding

1. **Explain** why atoms will often join together to form bonds.

2. **Explain** why table salt does not melt easily.

3. **Contrast** ionic and covalent bonds.

4. **Explain** why a triple bond between two nitrogen atoms is stronger than a double bond between two oxygen atoms.

5. **Explain** how it is possible for a compound to have both ionic and covalent bonds.

6. **Predict** whether a gold ring would be a good conductor of electricity. What kind of bonds does gold have? How do these bonds explain gold's properties?

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Compound Names and Formulas

1. **Explain** the difference between iron(II) nitrate and iron(III) nitrate. What is the significance of the Roman numerals?

_____

_____

2. **Name** the following ionic compounds, keeping in mind that a transition metal cation must include its charge.

_____ **a.** TiO_2

_____ **b.** $BaCl_2$

_____ **c.** $CuCl_3$

_____ **d.** KI

_____ **e.** $SrCl_2$

_____ **f.** $CuBr_2$

3. **Describe** how covalent compounds are named.

_____

_____

_____

_____

_____

4. **Write** the chemical formulas for the following compounds:

_____ **a.** lithium oxide (ionic)

_____ **b.** carbon monoxide (covalent)

_____ **c.** carbon tetrachloride (covalent)

_____ **d.** nitrogen trifluoride (covalent)

_____ **e.** calcium chloride (ionic)

5. **Contrast** molecular formulas and empirical formulas.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Organic and Biochemical Compounds

1. **Identify** the following compounds as alkanes, alkenes, or alcohols based on their names.

_____ **a.** 1-propanol

_____ **b.** cyclopentene

_____ **c.** cyclopentanol

_____ **d.** methylcyclopropane

_____ **e.** 2-butene

_____ **f.** 2-ethylhexane

2. **Contrast** alkanes and alkenes, and give an example of each.

3. **Explain** the similarities between alcohol molecules and water molecules.

4. **Explain** how glucose and starch are related.

5. **Explain** why carbon can never form more than a total of four bonds.

6. **Explain** how the bases that form DNA make pairs.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: The Nature of Chemical Reactions

1. **Identify** the reactants and products in each of the following chemical reactions.

   a. $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$

   _____

   b. $2AgNO_3 + H_2SO_4 \rightarrow Ag_2SO_4 + 2HNO_3$

   _____

2. **Explain** where the energy to cook food comes from when a gas stove burns natural gas, CH_4, and oxygen, O_2.

   _____

   _____

   _____

3. **Describe** three signs that a chemical reaction has taken place, and give an example of each sign.

   _____

   _____

   _____

4. **Identify** the elements present in the original compound using the following statement of a chemical reaction. A white solid is heated and gives off carbon dioxide, CO_2, and water, H_2O, leaving behind sodium carbonate, Na_2CO_3.

   _____

5. **Contrast** endothermic and exothermic reactions.

   _____

   _____

   _____

6. **Predict** the products of the decomposition reactions of the following substances:

   a. mercury oxide, HgO

   _____

   b. silver oxide, Ag_2O

   _____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Reaction Types

1. **Name** the compound that is a reactant in all combustion reactions.

2. **Explain** how you can determine if a chemical reaction represents a single-replacement reaction or a double-replacement reaction.

3. **Describe** what happens during a reduction/oxidation reaction.

4. **Identify** which element is reduced and which is oxidized in the following equations:

   a. $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$

   b. $2Al + 3CuSO_4 \rightarrow 3Cu + Al_2(SO_4)_3$

5. **Classify** each of the following reactions:

   _____ **a.** $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

   _____ **b.** $Ca + S \rightarrow CaS$

   _____ **c.** $Ca_3(PO_4)_2 + 3H_2SO_4 \rightarrow 3CaSO_4 + 2H_3PO_4$

   _____ **d.** $SiO_2 + 2C \rightarrow Si + 2CO$

   _____ **e.** $2CaCO_3 \rightarrow 2Ca + 2C + 3O_2$

6. **Summarize** each of the five general types of chemical reactions.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Balancing Chemical Equations

1. **Balance** the following equations:

   a. $N_2O_5 + H_2O \rightarrow HNO_3$

   b. $Fe(OH)_3 \rightarrow Fe_2O_3 + H_2O$

   c. $Fe + O_2 \rightarrow Fe_2O_3$

   d. $Al + CuSO_4 \rightarrow Al_2(SO_4)_3 + Cu$

   e. $NaCl + H_2SO_4 \rightarrow Na_2SO_4 + HCl$

2. **Determine** the mole ratio for the following reaction: oxygen gas and carbon react to form carbon monoxide, CO.

3. **Determine** the number of moles of sodium hydroxide, NaOH, produced when 2 mol of sodium and 3 mol of water react to form sodium hydroxide and hydrogen gas, H_2.

4. **Calculate** the mass of carbon monoxide, CO, that was needed to produce 78 g of methanol, CH_3OH, by the following reaction: $2H_2 + CO \rightarrow CH_3OH$.

5. **Demonstrate** that the following chemical equation illustrates the conservation of mass in chemical reactions: $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Rates of Change

1. **State** Le Châtelier's principle.

2. **Describe** two ways you could make table salt dissolve faster in water.

3. **Predict** the shift of equilibrium for each of the following conditions in the following reaction involving gaseous reactants and products:
$N_2 + 3H_2 \rightleftarrows 2NH_3 + \text{heat}$.

   a. NH_3 is added to the reaction.

   b. NH_3 is removed from the reaction.

   c. The pressure is increased.

   d. The temperature is decreased.

4. **Predict** how each of the following changes will affect the following reaction involving gaseous reactants and products: $2NO_2 \rightleftarrows N_2O_4 + \text{heat}$.

   a. raising the temperature

   b. increasing the pressure

   c. removing N_2O_4 from the equilibrium mixture

   d. adding NO_2 to the equilibrium mixture

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Solutions and Other Mixtures

1. Classify each of the following mixtures as homogeneous or heterogeneous:

_____ **a.** lemonade with pulp

_____ **b.** coffee with cream and sugar

_____ **c.** vinegar

_____ **d.** dessert gelatin with pears in it

2. Compare suspensions, colloids, and solutions in terms of particle size and methods to separate each type of mixture.

_____

_____

_____

3. Explain why the air we breathe and solids such as steel and bronze, are solutions or homogeneous mixtures, just like salt water is.

_____

_____

_____

4. Identify the solute and solvent when sugar and water are mixed to form nectar for a hummingbird feeder.

_____

_____

5. After boiling a chicken in a stock pot, you let the chicken stock cool down and place it in the refrigerator overnight. The next day you notice that a solid layer of fat has formed on the top of a gelatinous mixture.

a. Explain why the chicken fat rose to the top.

_____

b. Describe how you could separate the fat from the gelatinous mixture.

_____

c. Give examples of two liquid solutions that do *not* contain water.

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: How Substances Dissolve

1. **Explain** how you can speed up the dissolving process when preparing juice from frozen concentrate.

2. **Explain** why water is sometimes referred to as the universal solvent.

3. **Draw** a water molecule. Indicate the area where the electrons would be found. Label each atom and include all charges.

4. You make a salad dressing by mixing water, vinegar, olive oil, and seasonings. After a while, the oil separates and forms a layer above the other components.

   a. Identify the polar and nonpolar liquids in the dressing.

   b. Compare the strength of the attractions between a water molecule and a molecule of vinegar and between a water molecule and a molecule of olive oil.

5. **Describe** what happens when sodium chloride dissolves in water.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Solubility and Concentration

1. **Summarize** how to produce three solutions of sugar in water: an unsaturated solution, a saturated solution, and a supersaturated solution.

2. **Describe** what happens to a saturated solution of sugar in water when the temperature of the solution is suddenly lowered by 10°C.

3. **Determine** how many grams of acetic acid should be dissolved in 100 g of water to make a 4.0 percent (by mass) solution of vinegar.

4. **Calculate** the molarity of a solution that contains 93.5 g of potassium chloride, KCl, dissolved in 500.0 mL of solution.

5. **Order** the following ionic compounds according to their solubility in water, from most soluble to least soluble. Refer to Table 1, "Solubilities of Some Ionic Compounds in Water," in your textbook.

   calcium chloride, sodium fluoride, silver nitrate, iron(II) sulfide, sodium iodide

6. When divers ascend too quickly, nitrogen dissolved in the blood comes out of solution, forming bubbles in the blood vessels. Treatment for this condition, known as the bends, involves placing the diver in a chamber where the pressure is higher than that of atmospheric pressure.

   Explain how increasing the pressure can help treat the bends.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Acids and Bases

1. Classify each of the following substances as acidic, basic, or neutral:

_____ **a.** a dilute solution of vinegar in water, which has more H_3O^+ ions than OH^- ions

_____ **b.** a solution with equal concentrations of H_3O^+ and OH^-

_____ **c.** a bitter liquid, pH = 8

_____ **d.** pure water, pH = 7

_____ **e.** a tart solution of mixed citrus juices, pH < 7

2. Compare two kinds of bases, and give an example of each type.

3. Compare the acidity of three solutions having pH values of 2, 3, and 6.

4. Write the balanced chemical equation that describes the dissociation of the strong base magnesium hydroxide, $Mg(OH)_2$, in water.

5. Determine the hydronium ion concentration (M) of an acid solution with a pH of 6.

6. Calculate the pH of a 0.0001 M solution of the strong acid, HCl.

7. Explain why sulfuric acid conducts electricity better than citric acid.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Reactions of Acids with Bases

1. **Write** the balanced ionic equation for the reaction between water solutions of nitric acid, HNO_3, and sodium hydroxide, NaOH. Circle the spectator ions.

_____

2. **Predict** whether the neutralization reaction of each of the following acids and bases will yield an acidic, basic, or neutral solution:

_____ **a.** hydrochloric acid, HCl, and calcium hydroxide, $Ca(OH)_2$

_____ **b.** citric acid, $H_3C_6H_5O_7$, and sodium hydroxide, NaOH

_____ **c.** nitric acid, HNO_3, and methylamine, CH_3NH_2

3. **Identify** the acid and base combined to produce the following salts:

_____ **a.** potassium nitrate, KNO_3

_____ **b.** calcium chloride, $CaCl_2$

_____ **c.** barium sulfate, $BaSO_4$

4. **Describe** what happens at the molecular level when the equivalence point is reached during the titration of sulfuric acid, H_2SO_4, and potassium hydroxide, KOH.

_____

_____

_____

5. **Name** two common salts and give a use for each.

_____

_____

6. **Predict** the pH of the solution obtained when a 1.0 M magnesium hydroxide solution, $Mg(OH)_2$, is titrated with an equal amount of a 1.0 M solution of sodium chloride, NaCl.

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Acids, Bases, and Salts in the Home

1. Classify the following household products as either acids or bases:

_____ **a.** soap

_____ **b.** bleach

_____ **c.** vitamin C

_____ **d.** baking soda

_____ **e.** clothing dyes

_____ **f.** antacid

_____ **g.** vinegar

_____ **h.** lye

2. Describe the role of soap as an emulsifier when washing oil or grease from your hands.

3. Explain why a substance containing only long hydrocarbon chains would not be a good emulsifier for mixtures of water and oil.

4. Hydrogen peroxide, H_2O_2, is a common bleaching agent and disinfectant readily available at the local drugstore as a 3 percent solution.

a. Describe what a disinfectant does.

b. Describe what a bleaching agent does.

5. Summarize what happens in your stomach when you take an antacid for indigestion.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: What Is Radioactivity?

1. Write in the blank the term that matches each description.

beta particles — alpha particles
neutron emission — gamma rays

_____ **a.** helium-4 nuclei

_____ **b.** high-energy electromagnetic radiation emitted by a nucleus

_____ **c.** electrons emitted by neutrons decaying into an unstable nucleus

_____ **d.** release of high-energy neutrons

2. Determine the amount of time it takes for three-fourths of a radioactive sample of an isotope of bromine to decay. The half-life of the isotope is 16.5 hours.

_____

3. Complete the following radioactive decay equations by identifying the isotope X. Indicate whether alpha or beta decay occurs.

a. $^{214}_{82}\text{Pb} \rightarrow {}^{A}_{Z}\text{X} + {}^{0}_{-1}\text{e}$ _____

b. $^{214}_{83}\text{Bi} \rightarrow {}^{A}_{Z}\text{X} + {}^{0}_{-1}\text{e}$ _____

c. $^{214}_{84}\text{Po} \rightarrow {}^{A}_{Z}\text{X} + {}^{4}_{2}\text{He}$ _____

4. Explain how it is possible that negatively charged beta particles are emitted from a positively charged nucleus during nuclear decay.

_____

_____

5. Determine the half-life of a radioactive substance that has changed through radioactive decay. After 40 days, the original substance left is one-sixteenth of the original amount.

_____

_____ **6. Identify** which of the following is true for gamma ray emission.

a. The atomic number increases but the atomic mass stays the same.
b. Both the atomic number and the atomic mass remain the same.
c. The atomic number decreases and the atomic mass increases.
d. The atomic number stays the same and the atomic mass decreases.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Nuclear Fission and Sustain

1. Write in the blank the term that matches each definition.

critical mass
fusion reaction
strong nuclear force

_____ **a.** attractive force that acts between nucleons at very short distances

_____ **b.** joining of two lighter nuclei to form a heavier nuclei

_____ **c.** the minimum mass of a fissionable isotope in which a nuclear chain reaction can occur

2. Describe how a fission reaction is started.

3. Describe a characteristic of a fissionable substance that is essential for a chain-reaction to sustain itself.

4. Explain why the energy associated with even a small mass is immense. (**Hint:** Consider the way *c* appears in the mass-energy equation.)

5. Describe how the strong nuclear force affects the composition of a nucleus.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Nuclear Radiation Today

_____ **1.** People receive some natural or background radiation exposure each day from
- **a.** the sun.
- **b.** household appliances such as television sets and microwave ovens.
- **c.** medical and dental X rays.
- **d.** All of the above

2. Determine whether the following statements are true or false.

_____ **a.** The longer a person is exposed to radiation and the closer the person is to the radiation, the greater the risk.

_____ **b.** Radiation cannot be detected by our sense of sight, smell, taste, hearing, or touch.

_____ **c.** Alpha particles gain energy as they ionize matter.

3. Explain why ventilation is very important if there is a risk of exposure to radon gas in your home or school.

4. Name the nuclear radiation(s) that can be easily stopped by skin or clothes.

5. Explain ionization. Which forms of nuclear radiation are capable of ionizing matter?

6. Explain one method of how nuclear radiation is used in the field of medicine.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Measuring Motion

1. **Select** the quantity that has changed—velocity or speed—for a car that travels north at 88 km/h and then turns east while continuing to move at 88 km/h. Explain your answer.

2. **Infer** how distance and speed in the motions of clock parts are used to measure time.

3. **Explain** how you can use the speedometer and a clock to tell how far you've traveled in a car if the car's odometer is not working. (**Hint:** Assume you are traveling at a constant velocity.)

4. **Calculate** the distance a plane flies on a 7.95-hour flight from Chicago to London. Assume a constant speed of 800.0 km/h.

5. **Determine** a skier's velocity in km/h, if it takes her 1.7 min to ski down a 1.67 km slope.

6. **Describe** how you could use two photographs taken at different times to prove that the moon is in motion.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Acceleration

1. **Calculate** the average acceleration of a car that changes speed from 0 m/s to 15 m/s in 5 s.

2. **Explain** why you are always accelerating when you ride a merry-go-round, even though the speed of the merry-go-round does not change.

_____

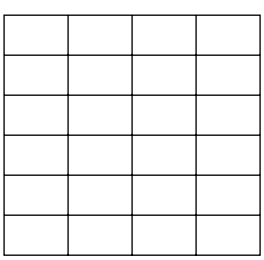
_____

_____

3. **a. Graph** the data from the table below onto a speed-time graph. Label both axes. Plot all the data points and draw a straight line connecting them.

CAR SPEED

Time (s)	Speed (m/s)
0	0
1	7.5
2	15.0
3	22.5
4	30.0



b. Determine the car's acceleration.

_____

4. **Calculate** how long it takes for a stone falling from a bridge with an average acceleration downward of 9.8 m/s^2 to hit the water. The stone starts from rest and hits the water with a velocity of 12.3 m/s.

5. **Identify** the straight-line accelerations below as either speeding up or slowing down.

_____ **a.** 0.75 m/s^2

_____ **b.** 24.8 m/s^2

_____ **c.** -3.9 m/s^2

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Motion and Force

1. **Suggest** why placing wheels under a heavy box reduces the necessary force required to push it along at a constant speed.

_____

_____

2. **Analyze** the following situations, and indicate whether the forces are balanced or unbalanced.

_____ **a.** a skydiver accelerating downward

_____ **b.** a cannonball fired parallel to the ground

_____ **c.** a motorboat coasting at a constant speed

_____ **d.** a bike leaning against a tree

3. **Evaluate** the change of motion in the following cases in which the forces on an object change from balanced to unbalanced.

a. The brake of a car parked on a hill is released.

_____

_____

b. A skydiver falling at a constant speed opens her parachute.

_____

_____

4. **Give** an example of harmful friction and describe how it can be reduced.

_____

_____

5. **Identify** the following examples of friction as harmful or helpful.

_____ **a.** friction between your hands as you rub them together for warmth

_____ **b.** friction between bones in a joint

_____ **c.** friction between a dentist's drill and your tooth

_____ **d.** friction between a saw blade and a piece of lumber

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Laws of Motion

1. **Interpret** the following situations to determine whether an object's velocity is being altered by an applied force (answer *Yes* or *No*).

   _____ **a.** a batter hits a baseball upward into right field

   _____ **b.** a satellite orbits Earth at a constant speed of 7000 m/s

   _____ **c.** a submarine moves due east at a constant speed of 45 m/s

   _____ **d.** a falling book lands on the floor with a pre-collision speed of 9 m/s

2. **Calculate** the acceleration of a 82 kg couch that is pushed across the floor with an unbalanced force of 21 N.

3. **Apply** Newton's first and second laws to explain why an object moving in a circular path at a constant speed is undergoing acceleration and has a force exerted on it.

4. **Determine** the force needed to accelerate a 1357 kg car forward at 8.0 m/s^2.

5. **Explain** why a backward-facing car seat is safer for an infant than a seat that faces forward during a collision or abrupt stop.

6. **Use** the concept of inertia to illustrate why volleyball is not played with a ball that has a mass similar to a bowling ball.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Gravity

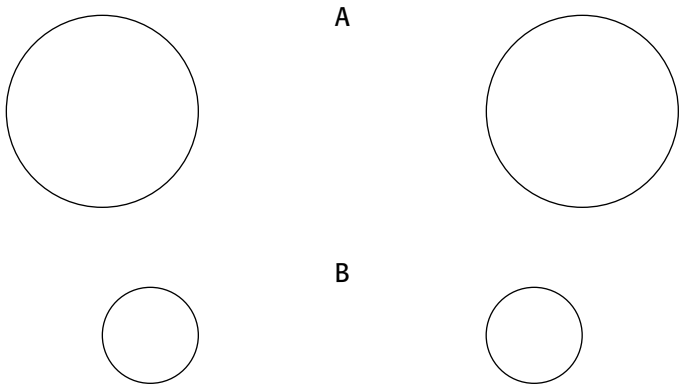
1. **Explain** why free-fall acceleration can be regarded as a constant for objects falling within a few hundred miles of Earth's surface.

_____

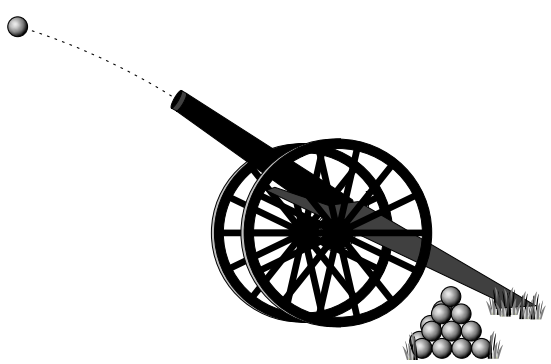
_____

_____

2. **Identify** which pair of objects would have greater gravitational force between them in the examples below. Use the law of universal gravitation to explain your answers.



3. **Predict** the path of the cannon ball below. To do this, draw a line in the direction of the cannon ball's flight. Also draw and label the horizontal and vertical components of the cannon ball's projectile motion.



4. **Calculate** the mass in kg of an object that weighs 1225 N on Earth.

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Motion and Force

1. **Suggest** why placing wheels under a heavy box reduces the necessary force required to push it along at a constant speed.

_____

_____

2. **Analyze** the following situations, and indicate whether the forces are balanced or unbalanced.

_____ **a.** a skydiver accelerating downward

_____ **b.** a cannonball fired parallel to the ground

_____ **c.** a motorboat coasting at a constant speed

_____ **d.** a bike leaning against a tree

3. **Evaluate** the change of motion in the following cases in which the forces on an object change from balanced to unbalanced.

a. The brake of a car parked on a hill is released.

_____

_____

b. A skydiver falling at a constant speed opens her parachute.

_____

_____

4. **Give** an example of harmful friction and describe how it can be reduced.

_____

_____

5. **Identify** the following examples of friction as harmful or helpful.

_____ **a.** friction between your hands as you rub them together for warmth

_____ **b.** friction between bones in a joint

_____ **c.** friction between a dentist's drill and your tooth

_____ **d.** friction between a saw blade and a piece of lumber

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Work, Power, and Machines

1. **Define** each of the following terms, and write the equation for each.

   a. work

   b. power

   c. mechanical advantage

2. **Explain** the relationship between work and power.

3. **Explain** how machines make work easier if they still require that the same amount of work be done.

4. **Calculate** the amount of work done when a grocery store stocker uses 120 N of force to lift a sack of flour 1.5 m onto a shelf.

5. **Calculate** the average power in kilowatts required to pull a car up a ramp if the amount of work is 250 kJ over a period of 45 s.

6. **Calculate** the mechanical advantage of a group of pulleys used to raise an engine from a car. The engine is raised 1.2 m with the pulleys when 4.8 m of rope is pulled through the pulleys.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Simple Machines

1. **Name** an example of each of the following types of simple machines:

_____ **a.** lever

_____ **b.** wedge

_____ **c.** pulley

_____ **d.** wheel and axle

_____ **e.** inclined plane

_____ **f.** screw

2. **Draw** the three types of levers, and label the input force, output force, and fulcrum on each.

First-class lever	Second-class lever	Third-class lever

3. **Compare** a wedge and a screw with an inclined plane.

_____

_____

4. **Describe** how an inclined plane increases the force without changing the amount of work done.

_____

_____

_____

5. **Explain** how a wheelbarrow is a compound machine.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: What Is Energy?

1. **Define** the following terms:

   a. kinetic energy

   b. potential energy

   c. mechanical energy

2. **Calculate** the gravitational potential energy of a 95 kg rock at the top of a 45 m cliff. The acceleration due to gravity is 9.8 m/s2.

3. **Calculate** the kinetic energy of a bicyclist traveling at 11 m/s. The total mass of the cyclist and the bike is 74 kg.

4. **Identify** the type of energy stored in a stretched bungee cord.

5. **Explain** how sunlight is converted into potential energy by plants.

6. **Explain** how the kinetic energy of an object changes when the speed of the object doubles.

7. **Contrast** chemical energy and mechanical energy.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Conservation of Energy

1. **Define** the term *efficiency*.

2. **List** two ways mechanical energy can be transformed to nonmechanical energy.

3. **Calculate** the efficiency of the following machines:

   a. A lever is used to lift a 45 N rock. The applied force is 75 N.

   b. A pulley system raises a 39 N log with an applied force of 45 N.

   c. You do 425 J of work to push a 75 N box up a ramp until the box is 2.5 m above the ground.

4. **Describe** why a high-efficiency machine is more desirable than a low-efficiency machine.

5. **Explain** why the height of a bouncing ball decreases after each bounce.

6. **Explain** how a skier gliding down a hill illustrates the conservation of energy.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Temperature

1. **Define** temperature in terms of kinetic energy.

2. **Explain** the difference between total and average molecular kinetic energy of a gas contained in a box.

3. **Explain** how a liquid thermometer measures temperature.

4. **Convert** the following temperatures as indicated.

   _____ **a.** What is 16°C on the Farenheit scale?

   _____ **b.** What is 95°F on the Celsius scale?

   _____ **c.** What is −30°C on the Kelvin scale?

   _____ **d.** What is 100 K on the Celsius scale?

5. **Predict** what will happen if a block of hot iron is placed in a glass of cool water.

6. **Evaluate** the following newspaper headline. Is it realistic? Explain.
   Scientists Create a Thermometer to Measure Temperatures Below 0 Kelvin

7. **Explain** why a metal door should not be built to fit tightly to the frame of a door, especially in a region where the weather gets hot.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Energy Transfer

1. **Explain** why a ceramic bowl will keep oatmeal hot longer than a stainless steel bowl.

2. **Explain** which method of heat transfer can take place if two objects at different temperatures are placed without touching each other in a vaccum.

3. **Calculate** how much energy must be transferred as heat in each of the following situations. Use the following equation:

$$energy = (specific\ heat) \times mass \times (temperature\ change)$$

   a. A 100 kg tank of water is warmed from 10°C to 25°C; specific heat = 4180 J/kg • K

   b. 100 kg of steam is raised from 120°C to 135°C; specific heat = 1870 J/kg • K

4. **Explain** why steam (gas) has a lower specific heat than water (liquid).

5. **Describe** the method of heat transfer involved when you mix hot water with cold water to make lukewarm water.

6. **Determine** which is the best type of skillet. Some people prefer a heavy cast iron skillet while others prefer a thin stainless steel one. (**Hint:** Think about how each skillet conducts heat.)

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Energy Transfer

1. **Explain** why a ceramic bowl will keep oatmeal hot longer than a stainless steel bowl.

2. **Explain** which method of heat transfer can take place if two objects at different temperatures are placed without touching each other in a vaccum.

3. **Calculate** how much energy must be transferred as heat in each of the following situations. Use the following equation:

$$energy = (specific\ heat) \times mass \times (temperature\ change)$$

   a. A 100 kg tank of water is warmed from 10°C to 25°C; specific heat = 4180 J/kg • K

   b. 100 kg of steam is raised from 120°C to 135°C; specific heat = 1870 J/kg • K

4. **Explain** why steam (gas) has a lower specific heat than water (liquid).

5. **Describe** the method of heat transfer involved when you mix hot water with cold water to make lukewarm water.

6. **Determine** which is the best type of skillet. Some people prefer a heavy cast iron skillet while others prefer a thin stainless steel one. (**Hint:** Think about how each skillet conducts heat.)

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Using Heat

1. **Explain** why placing a damp towel over a fan will increase its ability to cool a room.

2. **Apply** what you have learned about heating and cooling systems to the following situations, and determine whether the following are true. Explain your reasoning.

   a. Opening the door of the refrigerator will cool the kitchen.

   b. Shivering when you are cold actually warms you up.

   c. Desert jackrabbits have large ears to keep them cool.

3. **Describe** a method of insulation that can completely eliminate heat loss by conduction.

4. **Explain** how a diesel engine is different from other internal combustion engines.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Types of Waves

1. **Give** three examples of mechanical waves, and identify the medium through which they travel.

_____

_____

2. **a. Name** the one type of wave that does not require a medium.

_____

b. State what oscillates in this type of wave.

_____

3. **Describe** the motion of the particles in the medium for each type of wave. How does this motion compare to the direction the wave travels?

a. transverse wave

_____

b. longitudinal wave

_____

4. **Explain** what happens to the motion of a particle as a wave passes through a medium. How is the motion of the particle like the motion of a mass on a spring?

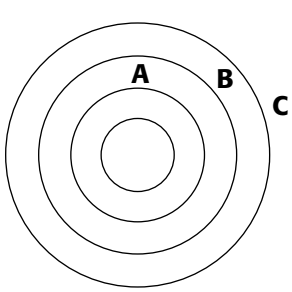
_____

_____

5. **Use** the figure below to answer the following questions. The figure shows a pattern of wave fronts that are formed when a pebble is dropped into a pool of water.

a. Compare the height of the wave fronts in circles A, B, and C.

_____



b. Indicate the wave front in which the energy of the wave is most spread out.

_____

c. Compare the amount of total energy in each of the wave fronts.

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Characteristics of Waves

1. State the wave property or characteristic described in each of the following:

_____ **a.** measures the amount of particle vibration

_____ **b.** is the lowest point of a wave

_____ **c.** measures how long it takes for a complete wave oscillation to occur

_____ **d.** measures the rate of particle vibration

_____ **e.** is the highest point of a wave

2. Determine which part of the electromagnetic spectrum is described in each of the following. Refer to **Table 1** in your textbook.

_____ **a.** have the greatest frequency

_____ **b.** have the greatest wavelength

_____ **c.** have the greatest period

3. Complete the following table. Indicate the changes that occur in the properties of a sound wave (frequency, pitch, wavelength, and wave speed) as a person experiences the Doppler effect.

	Increases	Decreases	Stays the same
As a source of sound moves toward a person			
As a source of sound moves away from a person			

4. Calculate the following for waves produced when you tap your finger in a pool of water twice each second.

a. What is the frequency of the waves you are generating? What is the period of the waves?

b. If the waves travel away from your finger with a speed of 1 m/s, what is their wavelength?

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Wave Interactions

1. **Describe** the behavior of the waves in the following situations, and give an example of each type of behavior.

   a. Waves strike a surface or boundary.

   _____

   _____

   b. Waves pass an edge or an opening.

   _____

   _____

   c. Waves pass from one medium to another.

   _____

   _____

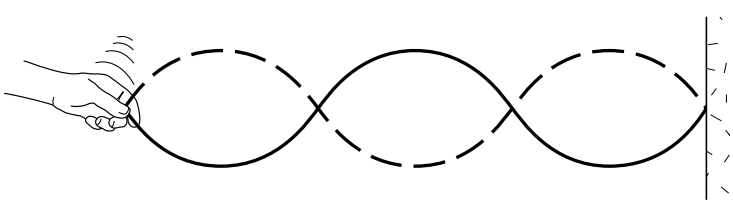
   d. Waves pass through another wave.

   _____

   _____

2. **Draw** two waves that will interfere constructively and two waves that will interfere destructively, and draw the resulting wave produced in each case. Label each case constructive or destructive interference.

3. **Determine** the wavelength of the standing waves in the figure below. The string is 1.5 m long.



Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Sound

1. **Explain** why the speed of sound changes if the temperature of the medium changes.

2. **Explain** what factors affect the loudness of a sound.

3. **Describe** how to change the pitch of a note played on a stringed instrument.

4. **Determine** which of the following has more harmonics in its sound— a tuning fork or a guitar. Explain.

5. **Describe** how longitudinal waves in the air produce longitudinal waves in the cochlear fluid of the inner ear.

6. **Determine** the following distances based on the sonar data given. A ship sends a sound pulse downward and receives the reflected sound 2.50 s later. (**Hint:** Use the formula $d = vt$. Assume the speed of sound in sea water is 1540 m/s.)

   a. the total distance traveled by the sound pulse

   b. the depth of the water

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: The Nature of Light

1. **Explain** what is meant by the "dual nature" of light.

_____

2. **Indicate** whether the following behaviors of light can best be described in terms of the particle model or the wave model.

_____ **a.** Light can produce interference patterns.

_____ **b.** Light can travel in a vacuum.

_____ **c.** Dim blue light can knock electrons off a metal plate, whereas bright red light cannot.

3. **Determine** which band of the electromagnetic spectrum has each of the following:

_____ **a.** the longest wavelength

_____ **b.** the highest frequency

_____ **c.** the greatest energy

_____ **d.** the least energy

4. **Explain** whether the photons emitted by a bright light bulb are more energetic than those emitted by a dim light bulb of the same color. How does the color of the light bulbs determine the amount of energy of the electromagnetic waves?

_____

_____

_____

5. **List** the regions of the electromagnetic spectrum in order of increasing energy.

_____

_____

6. **Describe** some uses of X rays and gamma rays in medicine.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Reflection and Color

1. **Contrast** the reflection of light from rough surfaces with that from smooth surfaces. Why do rough surfaces cause diffuse reflection?

2. **Use** the law of reflection to draw a sketch showing the incoming and reflected light rays when light shines on a mirror at an angle of 30° to the normal. Label the angle of incidence and the angle of reflection.

3. **Describe** the images produced by each of the following types of mirror:

   a. convex mirror

   b. concave mirror

4. **Draw** a diagram that shows how a plane mirror forms a virtual image.

5. **Indicate** what color a yellow cloth would appear to be if it were illuminated with

_____ **a.** sunlight.

_____ **b.** yellow light.

_____ **c.** blue light.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Refraction, Lenses, and Prisms

1. **Indicate** the direction that light is bent in each of the following situations.

   a. Light passes from air to water.

   _____

   b. Light passes from water to air.

   _____

2. **Explain** what causes a mirage.

   _____

   _____

3. **Define** total internal reflection, and give an example of its use in a practical device.

   _____

   _____

   _____

4. **Name** the type of lens that creates either virtual or real images, and state how light rays are bent by this type of lens.

   _____

   _____

5. **Describe** the function of each of the following parts of the eye.

   a. cornea

   _____

   b. pupil

   _____

   c. lens

   _____

6. **Explain** why prisms disperse white light.

   _____

   _____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Electric Charge and Force

1. **Describe** the interaction between two unlike charges.

_____

2. **Determine** the amount by which the electric force between two charges is increased when the distance between the charges is halved.

_____

3. **Categorize** the following as conductors or insulators:

_____ **a.** salt water

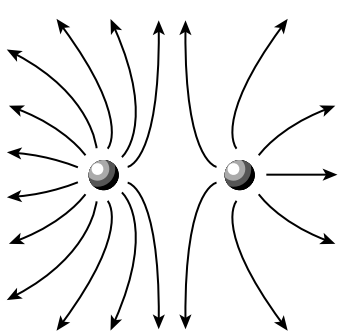
_____ **b.** a silver belt buckle

_____ **c.** a piece of wood

_____ **d.** a penny

_____ **e.** a candy bar

4. **Determine** whether each charge in the diagram below is positive or negative. Indicate which charge is greater.



5. **Suppose** the electric field in a region points upward.

   a. Determine the direction of the electric force on a proton placed in the field.

   _____

   b. Determine the direction of the electric force on an electron placed in the field.

   _____

   c. Compare the accelerations of the proton and electron placed in this electric field.

   _____

   _____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Current

1. **State** the condition that is necessary for a charge to move in a wire.

2. **Explain** how connecting an electric device to a battery produces a current in the device.

3. **Relate** the definition of electric current to the units of current.

4. **Describe** the cause of resistance and how the resistance of a wire can be determined.

5. **Calculate** the voltage required to produce a current of 2.0 A in a wire with a resistance of 16 Ω.

6. **Calculate** the amount of current in your fingers if they touch the terminals of a 12 V battery when the resistance of your skin is 650 Ω.

7. **Compare** superconductors and semiconductors with conductors and insulators.

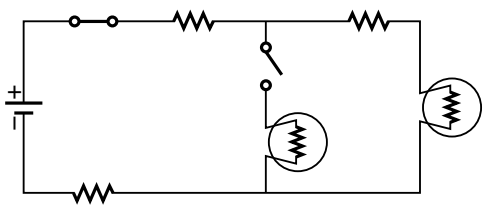
Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Circuits

1. **Identify** the types of elements in the schematic diagram shown below. Give the number of each type of element in the diagram.



2. **Predict** which fuse would give the greatest protection against high current in a circuit—a 20 A fuse or a 30 A fuse. Justify your answer.

3. **Contrast** series circuits and parallel circuits.

4. **Calculate** the power of a portable radio that operates on 24 V (two 12 V batteries in series) and draws 2.2 A of current.

5. **Calculate** the current drawn by a 4.0 W flashlight bulb that uses a 12 V battery.

6. **Calculate** the resistance of a 45 W light bulb that has a current of 0.38 A.

7. **Explain** why household appliances are almost always connected in parallel.

Name _____ Class _____ Date _____

Skills Worksheet

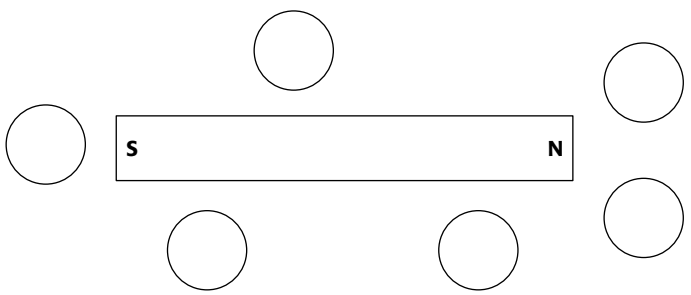
Concept Review

Section: Magnets and Magnetic Fields

1. **Draw** and label the orientation of two bar magnets that would attract each other and two bar magnets that would repel each other.

2. **Determine** how many north poles and south poles there are when you break a permanent magnet in half and then break each half in half.

3. **Draw** the magnetic field for the permanent magnet shown below, and draw the direction a compass needle would point at each point indicated.



4. **Compare** the strength of the magnetic field near one pole of a bar magnet with the strength of the magnetic field farther away from the magnet.

5. **Determine** which direction you are facing if the needle of a compass you are holding points directly to your left. Explain.

6. **Describe** the movement of a compass needle that is free to rotate in any direction as you fly straight from the north magnetic pole to the south magnetic pole.

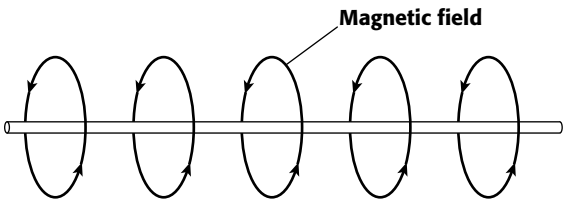
Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Magnetism from Electric Currents

1. **Determine** the direction of current in the wire below that produced the magnetic field shown. Indicate the direction of current and the direction that electrons move through the wire.



2. **Explain** why some materials are magnetic and some are nonmagnetic.

_____

_____

_____

3. **Determine** whether the magnetic field produced by a solenoid increases or decreases in each of the following cases:

_____ **a.** the number of coils is increased

_____ **b.** the current is decreased

4. **Use** the definition of magnetic domain to explain how an unmagnetized metal core is magnetized when it is inserted in a solenoid to make an electromagnet.

_____

_____

_____

_____

5. **Explain** why it is important that the current in the coil of a motor changes direction every time the coil makes a half revolution.

_____

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Electric Currents from Magnetism

1. **Describe** the basic condition necessary to produce a current in a circuit without a voltage source, and list the three methods of meeting this condition.

_____

_____

_____

2. **Determine** whether the current produced in a coil by electromagnetic induction would increase or decrease in each of the following cases:

_____ **a.** the number of loops in the coil is increased

_____ **b.** the strength of the magnet is decreased

_____ **c.** the loop is rotated so it is parallel to the field

3. **Explain** why the direction of the current produced by an AC generator alternates.

_____

_____

_____

4. **Describe** electromagnetic waves and how they can travel through empty space.

_____

_____

_____

5. **Indicate** whether the following transformers are step-up or step-down transformers:

_____ **a.** 50 turns in the primary coil; 40 turns in the secondary coil

_____ **b.** 40 turns in the primary coil; 50 turns in the secondary coil

_____ **c.** converts 120-V alternating current to 12-V alternating current

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Signals and Telecommunication

1. **Applying Knowledge** People who cannot hear use a finger alphabet to communicate. Examine the message below, then complete the following sentences.

   a. Each _____ stands for a letter of the alphabet.

   b. You need to know the _____ to decipher the message.

2. **State** two things from which communication signals are constructed, especially those used in sending long-distance messages.

_____

_____ 3. **Deduce** the relationship between the quality of sound and the sampling rate for sound recording. For a CD, the sampling rate is 44 100, which means that during the sound recording the air pressure is measured 44 100 times to represent the sound. The sampling rate of sound for telephone conversations is 8000. Based on your knowledge about the quality of the sound from a CD and from a telephone, deduce the relationship between the sampling rate and the quality of the sound.

   a. Sound quality is better when the sampling rate is lower.
   b. Sound quality is better when the sampling rate is higher.
   c. Sound quality is not affected by sampling rate.
   d. none of the above

4. **Describe** what happens when a person speaks into a microphone.

_____

_____

_____

5. **State** the two values used in binary code, and name the corresponding states in terms of electric current.

_____

6. **List** some objects in which sound is stored in digital format.

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Telephone, Radio, and Television

_____ **1. Identify** which of the following mediums or methods are used to transmit telephone signals.
- **a.** cables and wires that conduct electricity
- **b.** fiber-optic cables
- **c.** microwave transmission
- **d.** all of the above

2. Explain why three electron beams are enough to create a color image on a TV screen. Which three color phosphors are excited by the three electron beams?

_____

_____

_____

_____ **3. Describe** the fault in a broken telephone. The repair shop's diagnosis is that the membrane in the mouthpiece does not vibrate. Based on this information, what symptom or problem does the telephone exhibit?
- **a.** The voice from the speaker sounds broken.
- **b.** There is no sound in the earpiece of the receiver.
- **c.** The sound from your voice does not produce a changing current.
- **d.** all of the above

4. Predict what would happen if the tuner of a radio breaks.

_____

_____

5. Deduce a relationship between the quality of an image on a television screen and the number of scan lines that make an image on a TV screen. Recall that in the United States 525 scan lines are used for regular TV broadcast and 1250 scan lines are used for the new high-definition television (HDTV) broadcast.

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Computers and the Internet

1. a. Name two logic gates.

_____

b. Illustrate an OR logic gate that operates a porch light. The logic system consists of a light sensor and a temperature sensor. The light sensor comes on when there is no daylight present. The owners of the house have the habit of sitting out on the porch at night only when the outside temperature is above 75°F. And when they do sit out, they like the light on. So, the temperature sensor is programmed to go on if the outside temperature is above 75°F. (**Hint:** Use **Figure 24** in your book as a guide.)

c. Predict what happens to the porch light when it is daytime and the temperature is above 75°F.

_____

d. Applying Knowledge Based on the answer in part c, do you think the OR gate is the ideal choice for operating the porch light? If not, what kind of logic gate would you design?

_____

_____

2. Complete the following statements:

a. _____ is used for short-term storage of data and instructions.

b. _____ is used for permanent storage of operating instructions.

3. Name two types of optical mediums used to store computer data permanently.

_____

4. Describe the function of a modem (modulator/demodulator).

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Sun, Earth, and Moon

1. **Identify** the number of planets that orbit the sun.

2. **Identify** the force at work that keeps planets orbiting stars, and satellites orbiting planets.

3. **Draw** the positions of Earth, the moon, and the sun during a lunar eclipse.

4. **Explain** how the moon causes tides on Earth.

5. **Explain** why a solar eclipse does *not* occur during every new moon.

Name _____ Class _____ Date _____

Skill Worksheet

Concept Review

Section: The Inner and Outer Planets

1. Identify the planet that fits each description.

_____ **a.** largest planet in the solar system

_____ **b.** smallest planet in the solar system

_____ **c.** known for its runaway greenhouse effect

_____ **d.** tilted over on its side

_____ **e.** has the largest volcanoes

_____ **f.** first planet to be discovered using observed gravitational anomalies

_____ **g.** closest planet to the sun

_____ **h.** has the most extensive ring system

_____ **i.** the most habitable planet

2. Explain why the inner planets are known as terrestrial planets.

_____

_____

_____

3. Describe how specific characteristics of Earth permit it to sustain life.

_____

_____

_____

_____

4. List three characteristics of gas giants.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Formation of the Solar System

1. **Describe** how current models of the solar system differ from either Aristotle's or Copernicus' model.

2. **Identify** how long ago the original cloud of dust and gas started collapsing, according to the nebular model of the solar system.

3. **Explain** how the fact that most planets orbit in the same direction supports the nebular model.

4. **Explain** how the nebular model accounts for the differences between the inner and outer planets.

5. **Describe** the current theory of how Earth's moon was formed.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: The Life and Death of Stars

1. **Name** the two most common elements in stars.

2. **State** two reasons why one star may appear brighter than another star.

3. **Explain** how the color of a star is related to its temperature.

4. **Explain** how a star produces energy.

5. **Describe** the life of the sun from its birth to its death.

6. **Explain** why the sun does not collapse under the force of its own gravity.

7. **Describe** how elements are formed in stars.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: The Milky Way and Other Galaxies

1. Describe the components of a galaxy.

2. Draw a sketch of the Milky Way galaxy.

3. Define interstellar matter.

4. Explain how elliptical, irregular, and spiral galaxies differ from each other.

5. Describe two key aspects of quasars.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Origin of the Universe

1. Despite all the gas, dust and stars in the universe, the universe is still mostly _____.

2. **Explain** the difference between red shift and blue shift.

3. **Explain** how scientists know that the universe is expanding.

4. **Define** the big bang theory.

5. **Describe** the three possible outcomes of the universe.

6. **Explain** how dark matter affects models of the fate of the universe.

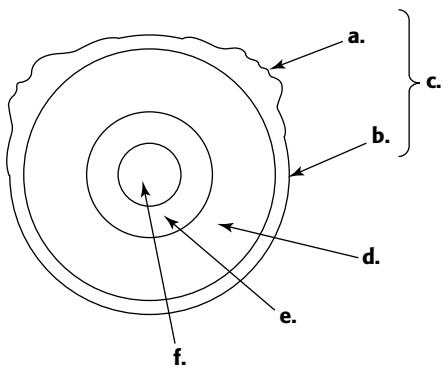
Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Earth's Interior and Plate Tectonics

1. Label the major layers of the Earth.



a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

2. Draw and label the three types of tectonic plate boundaries. Indicate the direction of movement for each plate.

3. Identify the geologic features that form at each of the following:

a. a convergent boundary between an oceanic plate and a continental plate

_____

b. a convergent boundary between two oceanic plates

_____

4. Summarize what scientists discovered when they analyzed the magnetic bands on the ocean floor.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Earthquakes and Volcanoes

1. **Define** each of the following:

   a. P waves

   b. S waves

   c. surface waves

2. **Describe** in your own words how a seismograph detects and records earthquakes.

3. **Explain** why most earthquakes occur at tectonic plate boundaries.

4. **Contrast** shield volcanoes and cinder cones.

5. **Explain** why volcanoes form at both convergent plate boundaries and divergent plate boundaries.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Minerals and Rocks

1. **List** the four characteristics of minerals.

_____

_____

2. **Identify** the type of rock described in each of the following:

_____ **a.** will have small crystals if cooled rapidly

_____ **b.** may contain fossils

_____ **c.** forms as a result of heat and pressure

3. **Describe** how each of the following types of rock is formed, and give an example of each.

a. sedimentary

_____

_____

b. metamorphic

_____

_____

4. **Describe** how igneous rock can become sedimentary rock.

_____

_____

_____

5. **Explain** why you would find the oldest fossils at the bottom of a cliff and the youngest fossils at the top of a cliff.

_____

_____

_____

6. **Explain** how the radioactive decay of isotopes is used to determine the age of rocks.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Weathering and Erosion

1. **Name** an example of the cause for each of the following:

   _____ **a.** physical weathering

   _____ **b.** chemical weathering

2. **Identify** whether physical weathering or erosion occurs in each of the following situations:

   _____ **a.** A deep gully forms in a hillside after a rainstorm.

   _____ **b.** A U-shaped valley is carved out as a glacier moves through the mountains.

   _____ **c.** A rock is slowly broken apart by the force of ice thawing and refreezing.

   _____ **d.** Sandstone is worn away by the sediment particles carried in the wind.

3. **Distinguish** between physical weathering and chemical weathering.

4. **Explain** how underground limestone caves form.

5. **Describe** how rainwater can be an agent of chemical weathering.

6. **Contrast** weathering and erosion.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Characteristics of the Atmosphere

1. **Name** the two main gases in the atmosphere, and state their relative percentages.

2. **Draw** a diagram of the layers of the atmosphere. Label the troposphere, stratosphere, mesosphere, ionosphere, and thermosphere.

3. **Predict** how increased carbon dioxide in the atmosphere would benefit plants.

4. **Explain** how CFCs affect the atmosphere and life on Earth.

5. **Describe** how a temperature inversion could affect the smog levels in the city of Los Angeles.

6. **Contrast** the temperatures in the troposphere and the stratosphere.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Water and Wind

1. **Define** the following terms:

   a. evaporation _____

   _____

   b. humidity _____

   _____

   c. precipitation _____

   _____

2. **Draw** examples of the following cloud types:

Cirrus	Stratus	Cumulus

3. **Explain** the relationship between air pressure and wind.

   _____

   _____

   _____

4. **Summarize** the general wind patterns in the Northern Hemisphere and in the Southern Hemisphere.

   _____

   _____

5. **Contrast** humidity and relative humidity.

   _____

   _____

   _____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Weather and Climate

1. **State** the safety procedures you should follow if a tornado is in your area.

2. **Draw** a diagram showing the sun and Earth's tilt on its axis when it is summer in the Southern Hemisphere.

3. **Explain** the difference between weather and climate.

4. **Describe** the process that causes lightning to occur during a thunderstorm.

5. **Contrast** cold fronts and warm fronts.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Organisms and Their Environment

1. **List** two living elements and two nonliving elements in the ecosystem of an ocean reef.

_____

_____

2. **Explain** how the word "interrelatedness" is a key to understanding the stability of an ecosystem.

_____

_____

3. **Evaluate** the following changes in ecosystems, and indicate whether they are short-term or long-term changes.

_____ **a.** During autumn, many trees and shrubs lose their leaves.

_____ **b.** A volcanic eruption takes place, leaving an island completely lifeless.

_____ **c.** A tropical rain forest is logged.

_____ **d.** To control insects, a gardener sprays his rose bushes with a soapy solution.

4. Complete the following statement: _____ changes in ecosystems are usually easily reversed but _____ changes can take many years to be reversed.

5. **List** a few human activities that cause changes in ecosystems.

_____

6. **Discuss** the importance of an "informed public" in that all citizens have a better understanding of how ecosystems work before they vote on the construction of dams, highways, malls, housing developments, etc.

_____

_____

7. **Explain** how the adverse effects of dams constructed before the 1970s are avoided by scientists and engineers today.

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Energy and Resources

1. **Name** the energy transfer process plants use to convert the sun's energy into stored chemical energy.

2. **State** where all fossil fuels come from, and give an example of a fossil fuel in each of the three phases (solid, liquid, gas).

3. **Name** the three most common ways in which electrical energy is generated.

4. **a.** State the two processes by which we obtain energy from the nucleus of an atom.

   b. Identify which of these two processes is used in present-day nuclear power plants.

   c. State a disadvantage of the use of nuclear power.

5. **Indicate** which of the following devices uses a renewable source of energy, and give an advantage and disadvantage of each.

   a. a fossil-fuel power plant

   b. a windmill

   c. a solar panel

   d. a hydroelectric dam

6. **Determine** what fraction of the energy produced by burning gas in the engine is converted to mechanical motion of a car that is only 25 percent efficient?

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

Section: Pollution and Recycling

1. **Discuss** how autopayment (having monthly household bills paid directly from a bank account) reduces the use of energy and cuts down on pollution.

2. **a. Describe** how the human activity of driving a car contributes to global warming.

   b. Describe the effects of global warming on Earth's climate.

3. **Describe** the harmful effects of acid rain on streams and lakes and on soil.

4. **List** three major contributors to water pollution.

5. **Explain** why contaminants in soil are hard to remove.

6. **Describe** the three ways of reducing pollution, and give an example of each.

Answer Key

Bellringer Transparencies

SECTION: THE NATURE OF SCIENCE

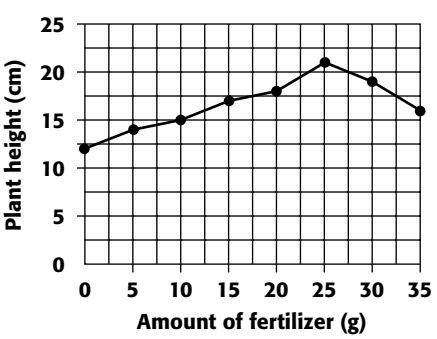
1. Answers will vary but may include physics, the study of the physical world; chemistry, the study of matter and how it changes; biology, the study of living things; ecology, the study of how living things interact with each other and with their nonliving environments; geology, the study of the physical nature and history of the earth; and astronomy, the study of the universe.
2. Answers will vary but may include television, radio, airplanes, telecommunications, applied genetics, and biotechnologies.
3. the law of conservation of mass, the law of conservation of energy

SECTION: THE WAY SCIENCE WORKS

1. **a.** N **e.** Y
   b. Y **f.** Y
   c. N **g.** Y
   d. N **h.** N
2. fertilizer, plants, soil, water, scale, gardening tools, ruler, measuring cup
3. height of plants, centimeters; amount of fertilizer, grams; amount of water, milliliters

SECTION: ORGANIZING DATA

1. 25 g of fertilizer
2. 0 g of fertilizer
3. Graphs will vary depending on their scales. Students should plot amount of fertilizer on the x-axis and plant height on the y-axis, as shown on the graph below.



4. Generally, plant height increases as more fertilizer is added to the plants.

Concept Reviews

SECTION: THE NATURE OF SCIENCE

1. Answers may vary. Possible answers include botany, zoology, ecology, medicine, agriculture, marine biology, and physiology.
2. **a.** a system of knowledge based on observations, discovered facts, and testable laws and principles **b.** the application of science to meet human needs **c.** a representation of an object or an event that can be studied to understand the real object or event
3. A scientific law summarizes an observed natural event without offering an explanation for it, while a scientific theory provides a possible explanation of a natural event.
4. Scientists must be objective in their observations so that their observations are accurate. If scientists only make observations that support a particular theory, they may overlook important observations that contradict their theory.
5. **a.** Scientists carefully plan experiments so that they will answer a particular question. **b.** Scientists repeat experiments to make sure that their results are accurate and can be duplicated.

SECTION: THE WAY SCIENCE WORKS

1. Answers may vary. Answers might include microscopes (used to magnify very small objects or the details of larger objects), telescopes (used to magnify distant objects, such as stars and galaxies), and particle accelerators (used to study the structure of atoms and the parts of atoms).
2. If more than one variable is tested, it is difficult to draw a definite conclusion from the results.
3. **a.** 0.95 m **b.** 1100 mL **c.** 17 km
   d. 500 000 g **e.** 0.002 55 mol
4. The original hypothesis may not be supported by experimental results.

The experiment may point to a new, more specific hypothesis.

5. Prefixes make it easy to express very large or very small numbers.
6. The SI units are used by scientists all over the world so that all scientists understand the data regardless of who generated the data.

SECTION: ORGANIZING DATA

1. **a.** 0.002 54 cm **c.** 0.33 L
   b. 95 000 km **d.** 744.5 g
2. **a.** 3.25×10^{2} kg **c.** 7.104×10^{3} km
   b. 4.6×10^{-4} m **d.** 2.8×10^{-3} L
3. **a.** 3 **c.** 6
   b. 4 **d.** 5
4. **a.** bar graph **c.** line graph
   b. pie chart
5. The data points might be located close together indicating precision, but they might not be close to the true value.

Science Skills

CREATING A CONCEPT MAP

1. Choosing the Main Concepts

Student answers will vary. Possible answers include organize ideas, outline, concept map, main ideas, boxes, lines, letters and numbers, show relationships, graphic, easy to remember.

2. Finding the Central Concept

Student answers may vary. Be sure a central concept is chosen. Possible answers include concept map, organize ideas.

3. Choosing Ideas that Surround the Central Concept

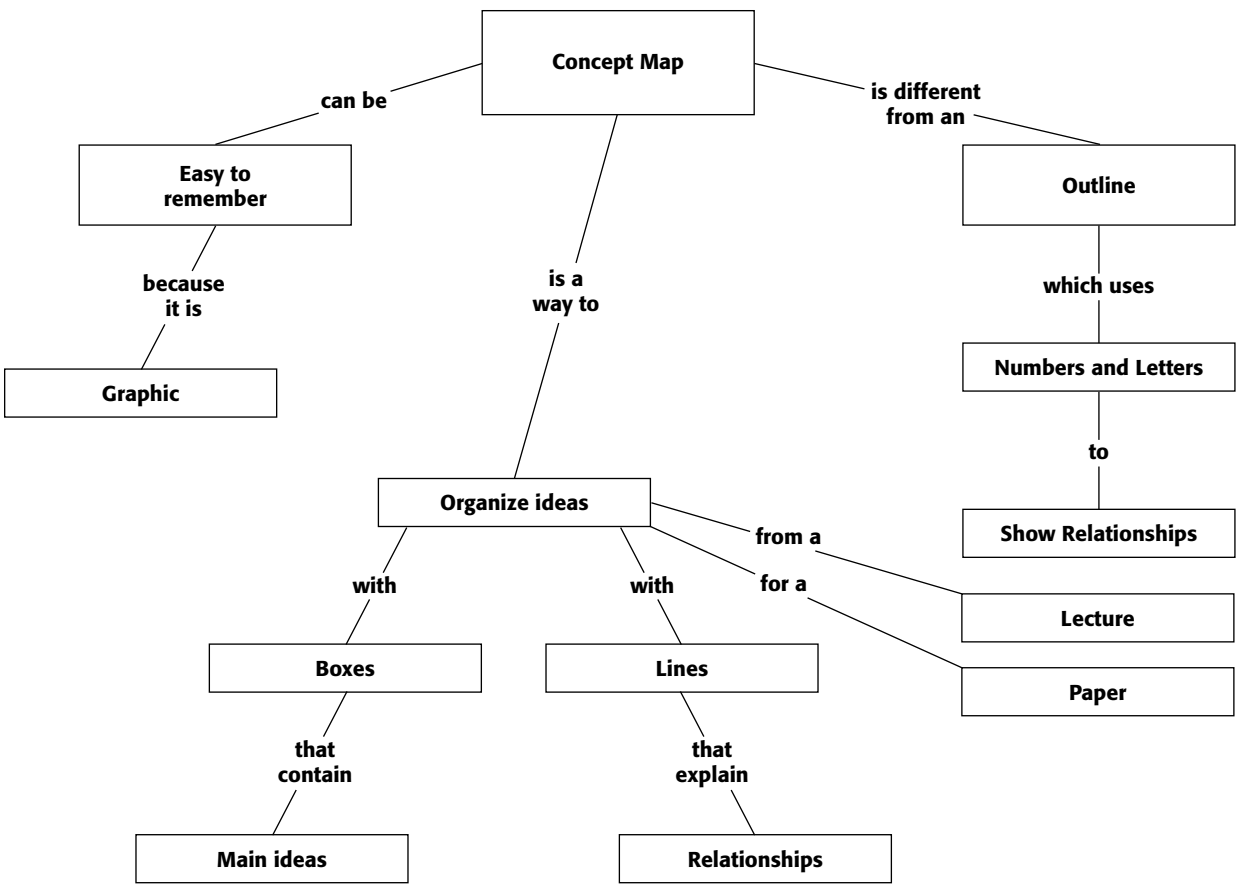
Student answers will vary. Verify that each concept around the central concept relates to the main concept directly. Also be sure that each main idea is in a box.

4. Showing the Relationships Between Ideas

Student answers will vary. Be sure that each line between boxes details the correct relationship between the concepts the line connects.

5. Expand your Concept Map

Student answers will vary. Be sure that each concept they listed in step one is included in a box, and that each line describes the relationship between the concepts it connects. One possible concept map for the introductory paragraphs is shown below.



Answer Key

Bellringer Transparencies

SECTION: WHAT IS MATTER?

1. **a.** magnesium **b.** bromine **c.** nitrogen **d.** bromine **e.** sulfur **f.** calcium **g.** boron **h.** zinc **i.** neon
2. iron, silver, sulfur, zinc

SECTION: PROPERTIES OF MATTER

1. The first, because the molecules are packed together tightly, and can't move.
2. The third, because the molecules are widely separated and don't touch.
3. solid and liquid
4. The third, because the particles don't touch, and have difficulty interacting.

SECTION: CHANGES OF MATTER

1. Iron filings, as the other substances are non-magnetic.
2. Sand, since it can't go through the filter.
3. Water evaporates, leaving behind the sugar.

Concept Reviews

SECTION: WHAT IS MATTER?

1. **a.** heterogeneous **b.** homogeneous **c.** heterogeneous **d.** heterogeneous **e.** homogeneous **f.** homogeneous
2. An atom is the smallest particle that has the properties of an element, while a molecule is the smallest unit of a substance that has the properties of that substance. Molecules consist of one atom or two or more atoms chemically joined together.
3. A pure substance is made up of matter that has a fixed composition and definite properties. Although a homogeneous mixture is uniformly mixed, it is a combination of more than one pure substance and does not necessarily have a fixed composition.
4. **a.** compound **b.** element **c.** compound **d.** element **e.** compound **f.** element
5. Elements are pure substances because each has a fixed composition of protons, neutrons, and electrons and particular characteristic properties. Compounds are pure substances because each has a fixed composition of atoms and definite properties.
6. **a.** mixture **b.** pure substance **c.** pure substance **d.** pure substance **e.** mixture **f.** mixture

SECTION: PROPERTIES OF MATTER

1. **a.** physical **b.** chemical **c.** physical **d.** physical **e.** chemical
2. **a.** physical **b.** chemical **c.** physical **d.** physical **e.** physical
3. Aluminum is light, durable, and inexpensive (physical properties), and nonreactive (chemical property).
4. 136.3 g silver
   $m = DV$
   $= (10.49\ g/cm^3)(12.99\ cm^3) = 136.3\ g$
5. 2.3 g/cm^3
   $D = m/V$
   $= (820\ g)/(350\ cm^3) = 2.3\ g/cm^3$
6. Characteristic properties are properties a substance is known for. In this case, ice is known for its coldness and solidity, but not for its heat of fusion (energy required to melt a standard amount of ice).

SECTION: CHANGES OF MATTER

1. **a.** physical **b.** chemical **c.** physical **d.** physical **e.** chemical **f.** chemical
2. The properties of the compound are unaffected.
3. New substances are formed by the application of heat.
4. Physical—properties unaffected, same substances
   Chemical—new properties, new substances
5. color or smell change, or sound or gas production

Answer Key

Bellringer Transparencies

SECTION: MATTER AND ENERGY

1. **a.** gas, molecules only
   b. gas, atoms only
   c. liquid, atoms only
   d. gas, atoms and molecules
   e. liquid, atoms and molecules
   f. solid, atoms and molecules
   g. solid, atoms only
   h. liquid, molecules only
   i. gas, atoms only
2. d, i

SECTION: FLUIDS

1. less; The buoyant force cannot equal the gold's weight, so the gold sinks.
2. greater; The buoyant force exceeds the balloon's weight, so the balloon rises.
3. equal; The weight of the boat is balanced by the buoyant force.
4. equal; The weight of the submarine is balanced by the buoyant force at the depth at which the submarine cruises.

SECTION: BEHAVIOR OF GASES

1. a
2. b
3. a

Concept Reviews

SECTION: MATTER AND ENERGY

1. **a.** liquid **b.** gas **c.** solid **d.** plasma
2. **a.** added **b.** fastest **c.** vaporization/evaporation **d.** absorbed **e.** slow down **f.** condensation **g.** released
3. The sugar molecules will have a lower speed on average than the water molecules because the sugar molecules are more massive than the water molecules. As the temperature of the mixture increases, the speed of all of the molecules will increase.
4. The total number of water molecules, and therefore the mass, stays the same; the molecules are just spread out over a greater volume. Energy is transferred from the surroundings to the water, so the water molecules are moving faster than they were, but the total amount of energy is the same.

SECTION: FLUIDS

1. An object in a fluid medium displaces a set amount of fluid upon immersion. Archimedes' principle states that the weight of the displaced fluid is equal to the buoyant force exerted on the object.
2. The buoyant force exerted on the wood is equal to the weight of the wood.
3. 150 000 Pa
4. A fluid in equilibrium contained in a vessel exerts a pressure of equal intensity in all directions.
5. 33 250 N
6. As the speed of a moving fluid increases, its pressure decreases.

SECTION: BEHAVIOR OF GASES

1. a) Boyle's law, b) Charles's law, c) Gay-Lussac's law
2. Solids have molecules fixed in relation to each other. Liquids have molecules capable of sliding past each other, but still stack together. Gases have molecules that are rarely in contact with each other. Also, solids have definite volume and shape. Liquids have definite volume and varying shape. Gases have varying shape and volume.
3. a
4. c
5. d
6. Either its pressure or volume must also change. Alternatively, both may change. The amplitude and direction of the changes depends on the original temperature change.

Math Skills

PASCAL'S PRINCIPLE

1. 80.6 N
2. 350.0 N
3. 293.6 N
4. 28 cm^2

Concept Reviews

SECTION: ATOMIC STRUCTURE

1. Check students' drawings. Drawings should include two protons and two neutrons clustered in the nucleus and two electrons moving around outside the nucleus. Protons have a +1 charge, electrons have a −1 charge, and neutrons have a charge of zero.
   proton mass $= 1.67 \times 10^{-27}$ kg
   electron mass $= 9.11 \times 10^{-31}$ kg
   neutron mass $= 1.67 \times 10^{-27}$ kg
2. Dalton proposed that each element is made up of unique atoms that cannot be subdivided, that all of the atoms of an element are the same, and that atoms from different elements join together to form molecules.
3. The outermost electrons of an atom have greater energy than the innermost electrons of an atom.
4. In both theories, electrons orbit the nucleus and each electron has an energy level associated with its location. In Bohr's model of the atom, electrons were thought to orbit the nucleus in set paths, much like planets orbiting the sun. In the modern atomic theory, the region in an atom where electrons are likely to be found is called an orbital. But the exact location of an electron cannot be determined according to this model.

SECTION: A GUIDED TOUR OF THE PERIODIC TABLE

1. **a.** Mn **b.** Pb **c.** C **d.** U **e.** Rn **f.** Ag
2. Atoms of elements that have the same number of valence electrons are located in the same group (column) of the periodic table.
3. The atomic number is the number of protons found in the nucleus of an atom. The mass number is the total number of protons plus neutrons found in the nucleus.
4. Atoms of Group 1 elements lose the one valence electron they have to form cations with a full outermost energy level. Atoms of Group 17 elements have seven valence electrons and gain one electron to form anions with a full outermost energy level.
5.

Isotope	Symbol	p	n	e^-
protium	$^{1}_{1}H$	1	0	1
deuterium	$^{2}_{1}H$	1	1	1
tritium	$^{3}_{1}H$	1	2	1

6. The average atomic mass of hydrogen is listed in the periodic table as 1.01 amu. This value is closest to the atomic mass of protium (the most common hydrogen isotope), which has an atomic mass of about 1.0 amu (one proton and no neutrons).

SECTION: FAMILIES OF ELEMENTS

1. **a.** alkali metal **b.** semiconductor **c.** transition metal **d.** alkaline-earth metal
2. **a.** other nonmetal **b.** halogen **c.** noble gas **d.** other nonmetal
3. **a.** no **b.** no **c.** yes **d.** yes **e.** no **f.** no
4. Chlorine is reactive because it needs to gain only one more electron to have a full outermost energy level. Argon is not reactive because it has a full outermost energy level.
5. **a.** similar **b.** similar **c.** different **d.** similar, both unreactive

SECTION: USING MOLES TO COUNT ATOMS

1. A mole is 6.022×10^{23} particles.
2. **a.** yes **b.** no **c.** yes **d.** yes
3. A large counting unit like the mole is used to count atoms because atoms are too small to count individually.
4. **a.** 40.08 g/mol **c.** 32.07 g/mol **b.** 58.93 g/mol **d.** 16.00 g/mol
5. List the given and unknown values. Write down the form of the molar mass that will convert moles to grams (grams in the numerator, moles in the denominator). Multiply the amount of the element by the conversion factor, and solve.
6. **a.** 12 g of Ne **c.** 150 g of Se **b.** 658 g of Xe **d.** 650 g of Au
7. **a.** 0.35 mol of H **c.** 0.50 mol of Cr **b.** 37.5 mol of B **d.** 0.26 mol of S

Answer Key

Bellringer Transparencies

SECTION: COMPOUNDS AND MOLECULES

1. Answers will vary. Two people are each wearing at least one sneaker. They are playing basketball. One shoots the ball at the goal. The other, who is wearing shorts, attempts to block the ball from entering the goal.
2. Answers will vary but may include blocks of the picture indicating whether the two people are playing basketball at a park or in a gym, blocks of the picture indicating whether or not the two people are playing alone, and blocks of the picture indicating whether the two people are playing for sport or for recreation.

SECTION: INOIC AND COVALENT BONDING

1. Accept any answers for this item that match a consistent scheme described in student answers for item 2. One possibility is described below.
   Category 1 Computer World, Family Computing, All About Computing, How to Use the Internet, Building a Web Site
   Category 2 Beautiful Homes, Home Decorating, Modern Housekeeping, Home Makers Magazine
   Category 3 Car Trends, Classic Cars, Easy Car Repairs, The Sports Car Story
   Category 4 The Healthy Man, Homeopathic Medicine, The Healthy Woman, The Health Newsletter, Good Nutrition
   Category 5 Auto Racing, Sporting Times, Sports and Scores, Golf for Everyone, Football Stories, Tennis Tips
   Category 6 Calling All Girls, Child's Play, Calling All Boys, Nursery Rhymes, Read Aloud Stories
2. similarity in content
3. Answers will vary depending on initial groupings.

SECTION: COMPOUND NAMES AND FORMULAS

1. **a.** gas, molecules only
   b. gas, atoms only
   c. liquid, atoms only
   d. gas, atoms and molecules
   e. liquid, atoms and molecules
   f. solid, atoms and molecules
   g. solid, atoms only
   h. liquid, molecules only
   i. gas, atoms only
2. d, i

SECTION: ORGANIC AND BIOCHEMICAL COMPOUNDS

1. 4 sticks of butter per pound, 12 eggs per dozen, 5 sticks of gum per pack, 2 shoes per pair, 500 sheets of paper per ream, 52 cards per deck
2. Six sticks of butter is equivalent to one and one-half pounds of butter, which can be measured from the large block of butter using the scale.

Concept Reviews

SECTION: COMPOUNDS AND MOLECULES

1. Separating the elements of a compound is harder because the bonds between the atoms must be broken.
2. **a.** 1 sodium cation, 1 chloride anion
   b. 1 carbon atom, 2 oxygen atoms
   c. 1 potassium cation, 1 bromide anion
   d. 1 nitrogen atom, 3 hydrogen atoms
   e. 1 magnesium cation, 1 oxide anion
3. A ball-and-stick model gives you a better idea of bond lengths and bond angles. A space-filling model gives you a better idea of the space occupied by atoms.
4. Substances with network structures have strong bonds holding the atoms or ions together. Much energy (a higher temperature) is needed to break these bonds.
5. Table salt has a strong network structure consisting of very tightly bonded sodium cations and chloride anions. Table sugar is made of individual mole-

cules. The bonds within each molecule are strong, but there are no bonds (just slight attractions) between molecules.

6. Because the boiling point of the compound is relatively low, the compound is likely to be in the form of individual molecules.

SECTION: IONIC AND COVALENT BONDING

1. Atoms join to form bonds so that each atom has a more stable electron configuration.
2. Table salt does not melt easily because the attractions between sodium ions and chloride ions are very strong, requiring a great deal of energy to break.
3. An ionic bond is formed by the attraction between oppositely charged ions. A covalent bond is formed when atoms share one or more pairs of electrons.
4. A triple bond is stronger than a double bond because 3 pairs of electrons are shared to form a triple bond, while only 2 pairs of electrons are shared to form a double bond.
5. A compound that contains one or more polyatomic ions has both ionic and covalent bonds. The atoms making up the polyatomic ion are covalently bonded. The polyatomic ion forms an ionic bond with an oppositely charged ion.
6. Gold has metallic bonds in which the electron clouds of the gold atoms overlap. This overlap allows electrons to be transferred from atom to atom easily; therefore, gold is a good conductor of electricity.

SECTION: COMPOUND NAMES AND FORMULAS

1. The charge of the iron ions in each compound is different. The Roman numeral shows that iron(II) nitrate contains Fe^{2+} ions while iron(III) nitrate contains Fe^{3+} ions.
2. **a.** titanium(IV) oxide
   b. barium chloride
   c. copper(III) chloride
   d. potassium iodide
   e. strontium chloride
   f. copper(II) bromide
3. A prefix is added to the name of the first element telling how many atoms of that element are in one molecule (unless there is only one atom). A prefix is also added to the name of the second element telling how many atoms of that element are in one molecule. In addition, the ending of the second element is replaced with the suffix *-ide*.
4. **a.** Li_2O **b.** CO **c.** CCl_4 **d.** NF_3 **e.** $CaCl_2$
5. The empirical formula for a compound tells the smallest whole-number ratio of atoms making up a molecule or formula unit of a compound. The molecular formula for a compound reports the actual numbers of atoms there are in one molecule of the compound.

SECTION: ORGANIC AND BIOCHEMICAL COMPOUNDS

1. **a.** alcohol **b.** alkene **c.** alcohol
   d. alkane **e.** alkene **f.** alkane
2. An alkane is an organic compound that has only single bonds between carbon atoms. Examples of alkanes are methane, ethane, and propane. An alkene is an organic compound that has at least one double bond between two carbon atoms. An alkene may also have single bonds between other carbon atoms. Examples of alkenes are ethene, propene, and butene.
3. Alcohol molecules (CH_3—OH or C_2H_5—OH) are similar to water molecules (H—OH) except that a hydrogen atom is replaced by a different group (i.e., a methyl, ethyl, or some similar group). Also, both alcohol molecules and water molecules have attractions between their molecules.
4. Starch is a polymer consisting of many bonded glucose molecules.
5. Carbon can never form more than four bonds because it has only four valence electrons.
6. Adenine always pairs with thymine. Cytosine always pairs with guanine.

Concept Reviews

SECTION: THE NATURE OF CHEMICAL REACTIONS

1. **a.** reactants: Fe_2O_3 and Al; products: Fe and Al_2O_3 **b.** reactants: $AgNO_3$ and H_2SO_4; products: Ag_2SO_4 and HNO_3
2. When the natural gas burns, the bonds in the molecule are broken and the energy is released as heat.
3. energy is released as light, heat, or sound: examples may include the flame produced by a match when it is struck; the production of a gas: examples may include how carbon dioxide is produced when bread is rising; a change in color: examples may include that apples turn brown when exposed to air
4. sodium, carbon, oxygen, and hydrogen
5. Energy is transferred to the reactants from the surroundings in an endothermic reaction. Energy is transferred to the surroundings from the reactants in an exothermic reaction.
6. **a.** Hg and O_2 **b.** Ag and O_2

SECTION: REACTION TYPES

1. oxygen
2. A single-replacement reaction will have one compound and one element as reactants and one compound and one element as products, while a double-replacement reaction has two compounds as reactants and two compounds as products.
3. Electrons are transferred between elements during the reaction. The substance that gains electrons is reduced and the substance that loses electrons is oxidized.
4. **a.** Ag is reduced, Cu is oxidized
   b. Cu is reduced, Al is oxidized
5. **a.** combustion **b.** synthesis **c.** double-displacement **d.** single-displacement **e.** decomposition
6. Synthesis reactions join substances to make a new, more complex compound. Decomposition reactions break a compound into at least two products. In combustion reactions, a substance reacts with oxygen. In single-replacement reactions, atoms of one element appear to take the place of atoms of another element in a compound. In double-replacement reactions, ions appear to be exchanged between compounds, producing a gas, a solid precipitate, or a molecular compound.

SECTION: BALANCING CHEMICAL EQUATIONS

1. **a.** $N_2O_5 + H_2O \rightarrow 2HNO_3$
   b. $2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O$
   c. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
   d. $2Al + 3CuSO_4 \rightarrow Al_2(SO_4)_3 + 3Cu$
   e. $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$
2. The mole ratio for $C : O_2 : CO$ is 2 : 1 : 2. (balanced equation is $2C + O_2 \rightarrow 2CO$)
3. 2 mol NaOH (balanced equation is $2Na + 2H_2O \rightarrow 2NaOH + H_2$)
4. 68 g CO
   (78 g CH_3OH) (mol CH_3OH/32 g) = 2.4 mol CH_3OH (2.4 mol CO) (28 g CO/mol CO) = 68 g CO
5. Each side of the equation has three sodiums, seven oxygens, six hydrogens, and one phosphorus. Because both sides have the same number of atoms of each element, mass is conserved.

SECTION: RATES OF CHANGE

1. If a change is made to a system in chemical equilibrium, the equilibrium shifts to oppose the change until a new equilibrium is reached.
2. Answers may vary. The table salt can be ground up into small particles. The temperature of the water can be increased.
3. **a.** toward the left **b.** toward the right **c.** toward the right **d.** toward the right
4. **a.** toward the left **b.** toward the right **c.** toward the right **d.** toward the right

Answer Key

Bellringer Transparencies

SECTION: SOLUTIONS AND OTHER MIXTURES

1.–5. Answers will vary. Be sure each is a mixture with its components listed.

6. All mixtures could be classified by uniformity of composition.

SECTION: HOW SUBSTANCES DISSOLVE

1. The sugar dissolves more quickly before ice is added. If ice is added first, the sugar does not dissolve as quickly.

2. It settles at the bottom of the glass.

3. The bottom of the tea or lemonade is sweeter than the rest.

4. Stir the tea or lemonade to help the sugar on the bottom of the glass dissolve.

SECTION: SOLUBILITY AND CONCENTRATION

1. water

2. sodium hypochlorite, acetic acid, sodium, carbon dioxide; no; In club soda, both sodium and carbon dioxide are dissolved in water.

3. The label would remain the same. This is because the concentration is given as a percentage, which remains unchanged for any volume of solution.

4. yes; The masses of solute would vary with the volumes of solution.

5. no; Carbon dioxide is a gas dissolved in water.

Concept Reviews

SECTION: SOLUTIONS AND OTHER MIXTURES

1. a. heterogeneous **c.** homogeneous
b. homogeneous **d.** heterogeneous

2. Particles in suspension are large and will eventually settle out, so they can be separated by filtering. Particles in a colloid are smaller and do not settle out. Particles in a solution are the smallest. Solutions can be separated by evaporation and distillation.

3. In each case, the solution looks uniform and is a uniform mixture of ions, atoms, or molecules that are microscopically undetectable and are spread throughout a single phase.

4. The sugar is the solute, or the substance that dissolves in a solution. The water is the solvent, or the substance that dissolves the solute to make a solution.

5. a. Liquid fat and water are immiscible, so the less dense fat rose to the top.
b. Skim or pour off the layer of fat while the stock is still warm, or cool the stock overnight and lift the solid fat off the surface of the stock.

6. Answers may vary. Sample answers include: fingernail polish remover, paint strippers, gasoline, diesel fuel, kerosene, and petroleum.

SECTION: HOW SUBSTANCES DISSOLVE

1. Answers may vary. Possible answers include using warm tap water to dissolve the concentrate, crushing the softened concentrate into smaller pieces, and stirring or shaking the solution.

2. Water is a charged polar molecule that can dissolve many substances.

3. Check students' drawings for accuracy. The drawing should include one oxygen atom and two hydrogen atoms. The hydrogen atoms should be close together on one side of the oxygen atom. Students should indicate that the electrons reside in an area closer to the oxygen atom than to the hydrogen atoms. The atoms should be labeled. The oxygen atom should be labeled with "δ–" and the hydrogen atoms should be labeled with "δ+".

4. a. Water and vinegar are the polar liquids. Olive oil is the nonpolar liquid.
b. Because vinegar dissolves in water, the attractions between the water molecules and the vinegar ions are stronger than the attractions between water molecules and stronger than the

attractions between vinegar ions. Olive oil is a nonpolar compound and water is a polar compound, so there are no strong attractions between water molecules and olive oil molecules.

5. Sodium and chloride ions break away from the solid and spread evenly throughout the solution.

SECTION: SOLUBILITY AND CONCENTRATION

1. You can produce an unsaturated solution by dissolving a small amount of sugar in water. The solution is unsaturated as long as it is able to dissolve more solute. Keep adding sugar until the solution cannot dissolve any more at the given conditions. The solution is saturated if no more solute will dissolve. Cooling the solution will produce a supersaturated solution at the new temperature.
2. At the cooler temperature, the solution becomes supersaturated and some of the solute may settle out of the solution to produce a saturated solution under the new conditions.
3. 4.0 g acetic acid
4. 2.51 M
5. silver nitrate > sodium iodide > calcium chloride > sodium fluoride > iron(II) sulfide
6. When a diver descends, water exerts pressure on the body. The nitrogen breathed in is dissolved into the blood, because of the increased pressure. As the diver ascends, the pressure decreases and the nitrogen begins to come out of the blood, forming painful and dangerous air bubbles in the blood vessels. By increasing the pressure on the diver's body, the nitrogen is forced back into solution with the blood. Then, the pressure can be lowered very slowly, allowing the nitrogen to come out of the blood at a safe rate.

Answer Key

Bellringer Transparencies

SECTION: ACIDS AND BASES

1. acid
2. base
3. base
4. acid
5. base
6. Possible answers include that acids are sour tasting and that they hurt an open cut.
7. Possible answers include that bases are not sour tasting and that they are slippery when dissolved in water.

SECTION: REACTIONS OF ACIDS WITH BASES

1. $HCl + NaOH \rightarrow NaCl + H_2O$
2. $HCl + KOH \rightarrow KCl + H_2O$
3. $HNO_3 + KOH \rightarrow KNO_3 + H_2O$
4. $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$
5. $HBr + AgOH \rightarrow AgBr + H_2O$
6. $HClO_4 + NaOH \rightarrow NaClO_4 + H_2O$
7. $2HNO_3 + Ba(OH)_2 \rightarrow Ba(NO_3)_2 + 2H_2O$
8. $H_2SO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + 2H_2O$

SECTION: ACIDS, BASES AND SALTS IN THE HOME

1. A particularly sour green apple is due to an excess of acid.
2. Baking soda is a base.
3. These chemicals in the stomach are acids.
4. Drain cleaners that contain lye are bases.
5. Most dirt on windows is slightly acidic.

Concept Reviews

SECTION: ACIDS AND BASES

1. **a.** acidic **b.** neutral **c.** basic **d.** neutral **e.** acidic
2. Strong bases contain hydroxide ions and weak bases react with water to form hydroxide ions. Examples of strong bases include sodium hydroxide, potassium hydroxide, magnesium hydroxide, and calcium hydroxide. Examples of weak bases include ammonia, methylamine, and aniline.
3. The solution with a pH of 3 is 10^3, or 1000, times more acidic than the solution with a pH of 6. The solution with a pH of 2 is 10 times more acidic than the solution with a pH of 3 and 10^4, or 10 000, times more acidic than the solution with a pH of 6.
4. $Mg(OH)_2 \rightarrow Mg^{2+} + 2OH^-$
5. 0.000001 mol/L or 10^{-6} M
6. pH = 4
7. Sulfuric acid is a strong acid, therefore it ionizes completely in water. Once in solution, the charged ions are able to move freely and conduct electricity. Citric acid is a weak acid and does not produce many ions in solution. With fewer charged particles in the solution, citric acid cannot conduct electricity well.

SECTION: REACTIONS OF ACIDS WITH BASES

1. $H_3O^+ + NO_3^- + Na^+ + OH^- \rightarrow NO_3^- + Na^+ + 2H_2O$; Na^+ and NO_3^- should be circled
2. **a.** neutral **b.** basic **c.** acidic
3. **a.** HNO_3 and KOH **b.** HCl and CaOH **c.** H_2SO_4 and $Ba(OH)_2$
4. Because H_2SO_4 is a strong acid and KOH is a strong base, they will both produce as many ions as possible. There will be an equal amount of H_3O^+ ions and OH^- ions in solution. At this point, the H_3O^+ ions and OH^- ions combine to form H_2O, and the pH of the solution will be around 7.
5. Answers may vary. Sample answers: sodium carbonate, used in manufacturing glass and added to wash to soften water; calcium chloride, used to de-ice streets and in some kinds of concrete; sodium stearate, an example of a soap
6. pH $\approx$ 14

SECTION: ACIDS, BASES, AND SALTS IN THE HOME

1. **a.** base **b.** base **c.** acid **d.** base **e.** acid **f.** base **g.** acid **h.** base
2. The negatively charged end of soap dissolves in water, while the uncharged end dissolves in oil. This causes the droplets of oil to stay suspended in water and to be rinsed off.
3. The long hydrocarbon chains would dissolve in the oil but would not dissolve in water, so the substance would not be able to mix the water and oil throughout one another.
4. **a.** It kills harmful bacteria or viruses. **b.** It removes the color from stains by oxidizing the compound responsible.
5. One cause of indigestion is an excess amount of stomach acid that irritates the stomach lining. When you take an antacid, which is basic, it neutralizes the excess stomach acid through an acid-base neutralization reaction.

Science Skills

SCIENTIFIC NOTATION

1. 2×10^4 Hz, 1.5×10^5 Hz
2. 5×10^{-3} cm/h, 2×10^{-2} cm/h
3. 1.66×10^8 km^2, 4.2×10^3 m
4. 1470 m/s
5. 0.000 000 01 cm

OPERATIONS WITH EXPONENTS

1. $b = a^9$
2. $x = y$
3. $y = x$
4. $y = x$

ENTERING EXPONENTS

1. 1953 125 cm^3
2. 166 375 km^3
3. 0.0001 kg

BALANCING CHEMICAL EQUATIONS

1. No; the equation is not balanced because there are 2 N atoms on the left side and 1 N atoms on the right side, and 4 O atoms on the left side and 2 O atoms on the right side.
2. $2H_2 + O_2 \rightarrow 2H_2O$
3. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
4. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
5. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + \ + 6H_2O$
6. The equation is already balanced.

CLASSIFYING ITEMS

1. Listing Each Category

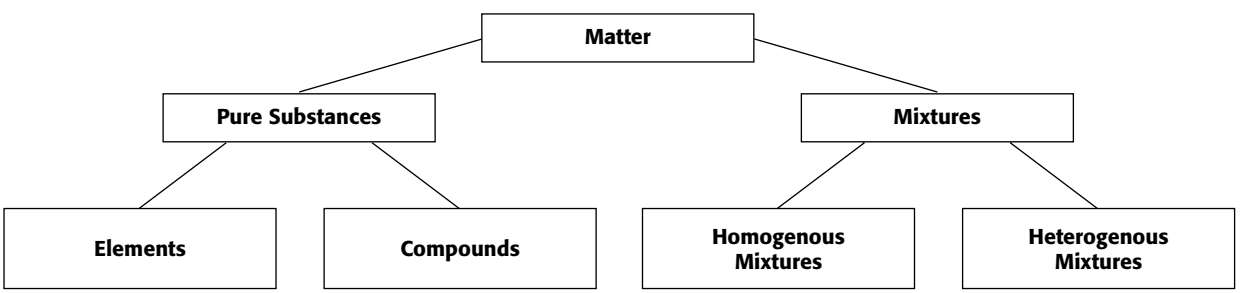
pure substances, mixtures, elements, compounds, homogeneous, heterogeneous

2. Arranging the Categories

Most general categories: pure substances, mixtures

Subdivisions: elements and compounds are pure substances; homogeneous and heterogeneous are types of mixtures

3. Drawing the Diagram



Answer Key

Bellringer Transparencies

SECTION: WHAT IS RADIOACTIVITY?

1. Black circles represent neutrons. White circles represent protons. The entire cluster is a nucleus.
2.

Atom	Protons	Neutrons
$^{32}_{15}$P	15	17
$^{60}_{27}$Co	27	33
$^{14}_{7}$N	7	7
$^{23}_{11}$Na	11	12
$^{32}_{16}$S	16	16
$^{210}_{84}$Po	84	126

SECTION: NUCLEAR FISSION AND FUSION

1. b
2. a
3. a; It forms larger atoms.

SECTION: NUCLEAR RADIATION TODAY

1. Energy is released.
2. Gamma radiation is likely to pass through the body more easily.
3. Alpha radiation was used because it is massive and able to collide with the gold atoms.

Concept Reviews

SECTION: WHAT IS RADIOACTIVITY?

1. **a.** alpha particles **c.** beta particles
   b. gamma rays **d.** neutron emission
2. 33 hours. If three-fourths decays, then one-fourth remains unchanged. After the first half-life, one-half of the sample is not changed. After the second half-life, one-fourth is unchanged. The amount of time is equal to $2 \times 16.5 = 33$ hours.
3. **a.** $^{214}_{83}$Bi, beta
   b. $^{214}_{84}$Po, beta
   c. $^{210}_{82}$Pb, alpha
4. The neutrons inside the nucleus decay into a proton and an electron. The electron is then ejected during beta-decay.
5. 10 days. One-sixteenth of the original substance will remain after 4 half-lives. This means 40 days is equal to 4 half-lives. So, one half-life is equal to 40 days/4 = 10 days.
6. d

SECTION: NUCLEAR FISSION AND FUSION

1. **a.** Strong nuclear force
   b. fusion reaction
   c. critical mass
2. Nuclear fission is started when a fissionable substance is bombarded by neutrons.
3. Answers may vary. Two possible answers are (1) an essential characteristic for a chain-reaction to sustain itself is that the fissionable substance consists of critical mass, and (2) each fission reaction should produce plenty of neutrons to trigger additional fission reactions.
4. Answers may vary. The answer should include that the value of c is very big, making c^2 even bigger. Hence, when you multiply a very large number by a small mass, the value of the energy equivalent to that mass is still immense.
5. Answers may vary. The answer should include that the strong nuclear force causes protons and neutrons in the nucleus to attract one another, overcoming the repulsion between protons.

SECTION: NUCLEAR RADIATION TODAY

1. a
2. **a.** T **b.** T **c.** F
3. Without proper ventilation, the concentration of radon in the house or school will get dangerously high.
4. alpha and beta rays
5. Ionization occurs when electrons are removed from neutral atoms or molecules. Alpha and beta rays are both capable of ionizing matter.

6. Answers may vary. Nuclear radiation can be used in imaging techniques, such as X-RAY and MRI, to help detect diseases. Radioactive tracers are also used to help detect tumors. Also, radiation therapy is used to treat patients with cancer.

Math Skills

NUCLEAR DECAY

1. $^{218}_{84}\text{Po}$
2. $^{205}_{83}\text{Bi}$
3. $^{233}_{90}\text{Th}$
4. $^{60}_{28}\text{Ni}$
5. $^{14}_{7}\text{N}$
6. $^{210}_{84}\text{Po}$
7. $^{4}_{2}\text{He}$, alpha
8. $^{4}_{2}\text{He}$, alpha
9. $^{0}_{-1}e$, beta

HALF-LIFE

1. $\frac{12.5\text{ g}}{100.0\text{ g}} = \frac{1}{8}$; three half-lives
$\frac{21.6\text{ s}}{3\text{ half-lives}} = \frac{7.2\text{ s}}{\text{half-life}}$
2. $\frac{100.0\text{ g}}{800.0\text{ g}} = \frac{1}{8}$; three half-lives
$\frac{639\,000\text{ y}}{3\text{ half-lives}} = \frac{213\,000\text{ y}}{\text{half-life}}$
3. $\frac{13\text{ g}}{208\text{ g}} = \frac{1}{16}$; four half-lives
$\frac{60.0\text{ h}}{4\text{ half-lives}} = \frac{15.0\text{ h}}{1\text{ half-life}}$
4. $\frac{6.25\text{ g}}{50.00\text{ g}} = \frac{1}{8}$; three half-lives
$8.1\text{ days} \times 3 = 24\text{ days}$
5. $\frac{1}{4}$; two half-lives
$0.025\text{ s} \times 2 = 0.050\text{ s}$
6. $\frac{11.25\text{ g}}{360.00\text{ g}} = \frac{1}{32}$; five half-lives
$21.6\text{ h} \times 5 = 108\text{ h}$
7. $\frac{62.0\text{ hr}}{\frac{12.4\text{ hr}}{\text{half-life}}} = 5$ half-lives; $\frac{1}{32}$
$848\text{ g} \times \frac{1}{32} = 26.5\text{ g}$
8. $\frac{1.719 \times 10^4\text{ y}}{5730\text{ y}} = 3$ half-lives; $\frac{1}{8}$
$144\text{ g} \times \frac{1}{8} = 18\text{ g}$
9. $\frac{2.82 \times 10^9\text{ y}}{7.04 \times 10^8\text{ y}} = 4$ half-lives; $\frac{1}{16}$
$12.5\text{ g} \times 16 = 2.00 \times 10^2\text{ g}$

Cross-Disciplinary

CONNECTION TO LANGUAGE ARTS: MARIE CURIE AND THE NAMING OF A UNIT

1. Marie and Pierre discovered polonium and radium.
2. A curie is a unit of radioactivity equal to the amount of a radioactive nuclide that decays at 3.7×10^{10} disintegrations per second.
3. Before she went to the university, Marie was a teacher and a governess.
4. No. Most women of her time were not involved in scientific careers.

CONNECTION TO SOCIAL STUDIES: A REMARKABLE DISCOVERY

1. 5370 years
2. More than half
3. 1600 atoms
4. 26 850 years

INTEGRATING CHEMISTRY: RADIOCHEMISTRY

1. Radiochemists further our understanding of chemical processes using the properties of radioactive isotopes.
2. This happens in neutron activation analysis.
3. Chemical reactions can be analyzed by converting one of the reactants into a radioactive isotope before the reaction takes place. After the reaction has occurred, the product can be measured for radioactivity to determine how much of the given reactant is present.

Answer Key

Bellringer Transparencies

SECTION: MEASURING MOTION

1. **a.** time
   b. distance
   c. time
   d. speed
   e. distance
2. **a.** s
   b. m
   c. s
   d. m/s
   e. m

SECTION: ACCELERATION

1. **a.** a change in velocity due to a change in speed
   b. no change in speed or direction of motion, so no change in velocity
   c. a change in velocity due to changes in both speed and direction of motion
   d. a change in velocity due to a change in the direction of motion
2. Its velocity will increase in the direction the student pulls it with the rope.

SECTION: MOTION AND FORCE

1. The marble rolls down the ramp due to the force of gravity.
2. The marble keeps rolling because no force is exerted on it until it strikes the front of the wagon.
3. The crumpled piece of paper would reach the floor first. The difference in surface area between these two pieces of paper accounts for the different forces on each one.

Concept Reviews

SECTION: MEASURING MOTION

1. The velocity has changed because the car's direction has changed.
2. Answers may vary. Sample answer: To measure time using an analog clock, you measure the rate at which angular distance, or circular distance, is covered by the minute and second hands of the clock.
3. To calculate the distance covered, you could use the clock to measure the total time the car has traveled. You must also note the speed shown on the speedometer. If the car is traveling at a constant velocity, then the distance covered is equal to $v \times t$.
4. 6360 km
5. 59 km/h downward
6. You would need to include a stationary reference point in both photos, such as a house or mountain. A change in position relative to the reference point would prove that the moon is in motion.

SECTION: ACCELERATION

1. 3 m/s^2
2. When you ride on a merry-go-round, you are traveling in a circle at a constant speed. Although your speed does not change, your direction is constantly changing. An object accelerates if its speed, direction, or both change.
3. **a.** Check students' graphs for accuracy. The x-axis should be labeled "Time (s)" and the y-axis should be labeled "Speed (m/s)". There should be a data point for each data pair on the table, (0, 0), (1, 7.5), (2, 15), (3, 22.5), and (4, 30). There should be a straight line connecting all the data points. **b.** The car's acceleration can be determined by calculating the slope of the line, 7.5 m/s ÷ 1 s = 7.5 m/s^2.
4. 1.3 s
5. **a.** speeding up **b.** speeding up
   c. slowing down

SECTION: MOTION AND FORCE

1. Placing wheels under a heavy box reduces the friction between the box and the ground, making it easier to push the box along at a constant speed.
2. **a.** unbalanced **b.** unbalanced
   c. balanced **d.** balanced

3. **a.** Under the force of gravity, the car will roll down the hill. It will accelerate as it rolls down the hill. **b.** The upward force on the skydiver due to air resistance increases, while the downward force due to gravity stays the same, so the skydiver slows down.
4. Answers may vary. Sample answer: Harmful friction occurs when you slide across a rough wooden bench. Smoothing the surface of the bench with sandpaper will reduce the friction.
5. **a.** helpful **b.** harmful **c.** helpful **d.** helpful

Science Skills

SLOPE OF A LINE

1. $\frac{1}{5}$
2. $\frac{0.6}{3.0}$ or $\frac{0.2}{1.0}$
3. speed

RATES OF CHANGE

1. 30 weeks (2 significant figures)
2. 15 weeks (2 significant figures)
3. 5 seconds

Math Skills

VELOCITY

1. $d = vt$

$t = 10.0\text{ h} \times \frac{3600\text{ s}}{\text{h}} = 3.6 \times 10^4\text{ s}$

$d = \frac{8.3\text{ m}}{\text{s}} \times (3.6 \times 10^4\text{ s}) = 3.0 \times 10^5\text{ m}$

$= 3.0 \times 10^2\text{ km}$

2. $d = vt$

$t = 3.4\text{ min} \times \left(\frac{60\text{ s}}{1\text{ min}}\right) = 2.0 \times 10^2\text{ s}$

$d = \frac{9.7\text{ m}}{\text{s}} \times (2.0 \times 10^2\text{ s}) = 1.9 \times 10^3\text{ m}$

$= 1.9\text{ km}$

3. $d = vt$

$d = \frac{121\text{ km}}{\text{h}} \times (3.33\text{ h}) = 403\text{ km}$

4. $d = vt$

$d = \frac{72\text{ km}}{\text{h}} \times (3.33\text{ h}) = 2.4 \times 10^2\text{ km}$

5. $t = \frac{d}{v}$

$t = \frac{22.30\text{ m}}{0.743\text{ m/s}} = 30.0\text{ s}$

6. $t = \frac{d}{v}$

$t = \frac{478\text{ km}}{97\text{ km/h}} = 4.9\text{ h}$

7. $t = \frac{d}{v}$

$t = \frac{6265\text{ km}}{2.150 \times 10^3\text{ km/h}} = 2.914\text{ h}$

$= 2\text{h } 54\text{ min } 50\text{ s}$

8. $t = \frac{d}{v}$

$t = \frac{10\,000\text{ m}}{5.644\text{ m/s}} = 1772\text{ s} = 29\text{ min } 32\text{ s}$

9. $v = \frac{d}{t} = \frac{274\text{ m}}{865\text{ s}} = 31.7\text{ m/s}$

10. $v = \frac{d}{t} = \frac{50.0\text{ m}}{\frac{1}{2}(49.17\text{ s})} = 2.03\text{ m/s}$

11. $3\text{ days} \times \frac{24\text{ h}}{1\text{ day}} = 72\text{ h}$

$72\text{ h} + 10\text{ h} = 82\text{ h}$

$40\text{ min} \times \frac{1\text{ h}}{60\text{ min}} = 0.67\text{ h}$

$t = 82.67\text{ h}$

$v = \frac{d}{t} = \frac{4727\text{ km}}{82.67\text{ h}} = 57.18\text{ km/h east}$

12. $v = \frac{d}{t} = \frac{\frac{1}{2}(32\,000\text{ km})}{122\text{ days}}$

$= 131\text{ km/day south}$

13. $d = vt =$

$(5.0 \times 10^{-2}\text{ m/h})(45\text{ min})\left(\frac{1\text{ h}}{60\text{ min}}\right)$

$= 3.8 \times 10^{-2}\text{ m}$

14. $\left(\frac{2.4 \times 10^5\text{ frames}}{1\text{ s}}\right) \times \left(\frac{7.5 \times 10^{-3}\text{ m}}{1\text{ frame}}\right)$

$= 1.8 \times 10^3\text{ m/s}$

15. $t = \frac{d}{v} = \frac{37\,900\text{ m}}{0.725\text{ m/s}} = 5.23 \times 10^4\text{ s}$

$5.23 \times 10^4\text{ s} \times \left(\frac{1\text{ min}}{60\text{ s}}\right) = 871\text{ min}$

$871\text{ min} \times \left(\frac{1\text{ h}}{60\text{ min}}\right) = 14\text{ h, } 31\text{ min}$

16. $d = vt = (12.9\text{ m/s})(5.00\text{ min})\left(\frac{60\text{ s}}{1\text{ min}}\right)$

$= 3.87 \times 10^3\text{ m} = 3.87\text{ km}$

17. $v = \frac{d}{t} = \frac{(1.0 \times 10^{-2}\text{ m})\left(\frac{1\text{ km}}{1000\text{ m}}\right)}{365\text{ days} \times \left(\frac{24\text{ h}}{1\text{ day}}\right)}$

$= 1.14 \times 10^{-9}\text{ km/h}$

18. $t = \frac{d}{v} = \frac{9354\text{ km}}{90.0\text{ km/h}} = 104\text{ h}$

19. $t = \frac{d}{v} = \frac{5530\text{ km}}{45\text{ km/h}} = 120\text{ h}$

Answer Key

Bellringer Transparancies

SECTION: LAWS OF MOTION

1. d
2. The person exerts a force on the wall, and the wall exerts an equal and opposite force on the person. The force increases to match the increased force of the person.

SECTION: GRAVITY

1. c, e, d, a, b
2. His weight will be less than it would be on the planet's surface.

SECTION: NEWTON'S THIRD LAW

1. equal; The force ont he tube is equal and opposite the force on the shell.
2. equal; The force on the skater is equal and opposite the force on the ball. The ball has a smaller mass than the skater and so accelerates more under the same-sized force.

Concept Review

SECTION: LAWS OF MOTION

1. **a.** Yes **b.** Yes **c.** No **d.** Yes
2. 2.6×10^{-1} m/s^2
3. From Newton's first law, we know that an object will move in a straight line at a constant speed as long as no force is acting on it. Since the object is moving in a circular path, there must be a force acting on it. From Newton's second law, we know that if a force is acting on an object it will produce an acceleration that is equal to F/m.
4. 1.1×10^4 N
5. During a collision or an abrupt stop, the infant would continue to move forward. If he were in a forward-facing car seat, there is a good chance he would injure his neck or other parts of his body. If he is placed in a backward-facing car seat, the back of the seat safely distributes the force pushing him forward.
6. Inertia is related to an object's mass. An object with a small mass will have less inertia than one with a larger mass. A bowling ball has a much greater mass than a volleyball and therefore will have more inertia, making it harder to throw or hit than a volleyball, and once in motion, harder to stop or change its direction.

SECTION: GRAVITY

1. Gravitational force depends on the distance between two objects. Because Earth's radius is very large compared with a few hundred meters, the gravitational force—and therefore free-fall acceleration—within a few hundred meters from Earth differs only very slightly from that on Earth's surface.
2. Pair A has the greater gravitational force. According to the law of universal gravitation, the more mass two objects have, the greater the gravitational force between them.
3. Students' drawings should show the cannon ball's path as an arc. Students should also draw a horizontal line, labeled "horizontal component" coming from the cannon ball's origin, and a vertical line coming from the cannon ball's origin, labeled "vertical component".
4. 125 kg

SECTION: NEWTON'S THIRD LAW

1. **a.** third **b.** first **c.** second **d.** second
2. When two billiard balls that have the same speed collide, they exert forces on each other that are equal and opposite, so the two billiard balls will move in the opposite direction without a change in their speeds.
3. Trains have enormous mass, so even a slow-moving train has a large momentum. A bullet has a very small mass, but when it moves at a very high speed, it has a large momentum.

4. All three objects have equal momentum.

$p = mv$ = (500 kg)(64 km/h)
= (250 kg)(128 km/h)
= (1000 kg)(32 km/h)
= 3.2×10^4 kg • km/h

5. If we assume that the car's mass is not changing, then a car that is moving with a constant momentum is traveling at a constant velocity.

Science Skills

REARRANGING ALGEBRAIC EQUATIONS

1. $l = A/w$

2. $t = d/v$

3. $w = V/(l \times h)$

4. $\Delta t = E/(cm)$

ORDERING MULTIPLE OPERATIONS

1. 34

2. 267

3. 84

4. 4

5. 821

EQUATIONS INVOLVING A CONSTANT

1. 4.0×10^{-7} m

2. 170 kg • m/s^2, or 170 N

Math Skills

NEWTON'S 2ND LAW

1. $a = \frac{F}{m} = \frac{2.03 \times 10^{20}\text{ N}}{7.35 \times 10^{22}\text{ kg}} = 2.76 \times 10^{-3}\text{ m/s}^2$

2. $a = \frac{F}{m} = \frac{-65.0\text{ N}}{0.145\text{ kg}} = -448\text{ m/s}^2$

3. $a = \frac{F}{m} = \frac{60.0\text{ N}}{1.50 \times 10^2\text{ kg}} = 0.400\text{ m/s}^2$

4. $a = \frac{F}{m} = \frac{-1310\text{ N}}{214\text{ kg}} = -6.12\text{ m/s}^2$

5. $m = \frac{F}{a} = \frac{3.6\text{ N}}{9.8\text{ m/s}^2} = 0.37\text{ kg}$

6. $m = \frac{F}{a} = \frac{2.5 \times 10^4\text{ N}}{1.25\text{ m/s}^2} = 2.0 \times 10^4\text{ kg}$

7. $m = \frac{F}{a} = \frac{F}{\frac{\Delta v}{t}} = \frac{2850\text{ N}}{\frac{0.15\text{ m/s} - 0\text{ m/s}}{5.0\text{ s}}} = 9.5 \times 10^4\text{ kg}$

8. a. $F_{\text{unbalanced}} = F_{\text{applied}} - F_{\text{friction}} = 2.8\text{ N} - 2.6\text{ N} = 0.2\text{ N}$

b. $m = \frac{F}{a} = \frac{0.2\text{ N}}{0.11\text{ m/s}^2} = 2\text{ kg}$

9. $F = ma = (1250\text{ kg}) \times (16.5\text{ m/s}^2) = 2.06 \times 10^4\text{ N}$

10. $F = ma = (5.22 \times 10^7\text{ kg}) \times (-0.357\text{ m/s}^2) = -1.86 \times 10^7\text{ N}$

11. $F = ma = (1.3 \times 10^4\text{ kg}) \times (-27.6\text{ m/s}^2) = -3.6 \times 10^5\text{ N}$

12. $F = ma = (2.0 \times 10^6\text{ kg}) \times (0.85\text{ m/s}^2) = 1.7 \times 10^6\text{ N}$

13. $a = \frac{F}{m} = \frac{7.23 \times 10^5\text{ N}}{7.7 \times 10^4\text{ kg}} = 9.4\text{ m/s}^2$

14. $m = \frac{F}{a} = \frac{F}{\frac{\Delta v}{t}} = \frac{-65\text{ N}}{\frac{0\text{ m/s} - 1.3\text{ m/s}}{0.30\text{ s}}} = 15\text{ kg}$

15. $F = ma = m\left(\frac{\Delta v}{t}\right) = (2.0 \times 10^{-4}\text{ kg})\left(\frac{1.58 \times 10^4\text{ m/s} - 0\text{ m/s}}{1.0\text{ s}}\right) = 3.16\text{ N}$

16. $a = \frac{F}{m} = \frac{7.07 \times 10^4\text{ N}}{1.33 \times 10^5\text{ kg}} = 0.532\text{ m/s}^2$

17. a. $m = \frac{F}{a} = \frac{-6.41 \times 10^{12}\text{ N}}{-1.00 \times 10^8\text{ m/s}^2} = 6.41 \times 10^4\text{ kg}$

b. $m = \frac{F}{a} = \frac{-6.41 \times 10^{12}\text{ N}}{-4.90 \times 10^9\text{ m/s}^2} = 1.31 \times 10^3\text{ kg}$

18. a. $\textit{initial } v = 172.8\text{ km/h} \times \left(\frac{1000\text{ m}}{1\text{ km}}\right) \times \left(\frac{1\text{ h}}{60\text{ min}}\right) \times \left(\frac{1\text{ min}}{60\text{ s}}\right) = 48\text{ m/s}$

$a = \frac{\textit{final } v - \textit{initial } v}{t} = \frac{0\text{ m/s} - 48\text{ m/s}}{2.72 \times 10^{-2}\text{ s}} = -1.8 \times 10^3\text{ m/s}^2$

$\times \frac{1.8 \times 10^3\text{ m/s}^2}{9.8\text{ m/s}^2} = 180$

b. $F = ma = (70.0\text{ kg}) \times (1.8 \times 10^3\text{ m/s}^2) = 1.3 \times 10^5\text{ N}$

Answer Key

Bellringer Transparencies

SECTION: WORK, POWER, AND MACHINES

1. d
2. The person exerts a force on the wall, and the wall exerts an equal and opposite force on the person. The force increases to match the increased force of the person.

SECTION: SIMPLE MACHINES

1. The fulcrum of a door is along its hinges.
2. Pushing near the side farthest from the hinges requires the least force to open a door.
3. The doorstop will work best near the side farthest from the hinges.

SECTION: WHAT IS ENERGY?

1. The sun's energy is captured by plants, which are eaten as food. This food provides a release of energy for other uses, such as swinging the bat.
2. Yes, because the ball moves a distance in response to the force.
3. The energy is absorbed in the glove and hand of the fielder. Some energy is also released as sound when the fielder catches the ball.

SECTION: CONSERVATION OF ENERGY

1. The sled has the most potential energy at the top of the hill and the least potential energy at the bottom of the hill.
2. The sled has the most kinetic energy at the bottom of the hill and the least kinetic energy at the top of the hill.
3. The potential energy decreases, the kinetic energy increases, but the total energy remains the same.
4. This energy is transformed into heat by the friction between the runners of the sled and the snow.

Concept Reviews

SECTION: WORK, POWER, AND MACHINES

1. **a.** Work is a quantity that measures the effects of a force acting over a distance. $W = F \times d$ **b.** Power is a quantity that measures the rate at which work is done. $P = W/t$ **c.** Mechanical advantage *(MA)* is a quantity that measures how much a machine multiplies force or distance.
   MA = output force/input
   = distance/output distance
2. Power is the rate at which work is done. Power equals the amount of work done per unit time: $P = W/t$.
3. Machines make work easier by allowing you to apply less force at any given moment.
4. 1.8×10^2 J
   $W = Fd = (120\text{ N})(1.5\text{ m}) = 180\text{ J}$
5. 5.6 kW
   $P = W/t = (250\,000\text{ J})/(45\text{ s})$
   $= 5.6 \times 10^3$ J/s
   $= 5.6$ kW
6. 4.0

$$MA = \frac{input\ distance}{output\ distance} = \frac{(4.8\text{ m})}{(1.2\text{ m})} = 4.0$$

SECTION: SIMPLE MACHINES

1. Answers will vary. Sample answers: **a.** crowbar **b.** ax head **c.** pulley on a flagpole **d.** car tire, steering wheel **e.** wheelchair ramp **f.** machine screw, jar lid
2. Check students' drawings. Labels should show input force, output force, and fulcrum.
3. A wedge and a screw are both modified inclined planes. A wedge functions like two inclined planes back to back. A screw is an inclined plane wrapped around a cylinder.
4. An inclined plane turns a small input force into a large output force by spreading the work out over a large distance.

5. A wheelbarrow is a second-class lever, and it has a wheel-and-axle on which it moves.

SECTION: WHAT IS ENERGY?

1. **a.** Kinetic energy is the energy of a moving object due to its motion.
   b. Potential energy is stored energy resulting from the relative positions of objects in a system. **c.** Mechanical energy is the sum of the kinetic and potential energy of large-scale objects in a system.
2. 4.2×10^4 J; $PE = mgh =$ $(95 \text{ kg})(9.8 \text{ m/s}^2)(45 \text{ m}) = 4.2 \times 10^4$ J
3. 4.5×10^3 J; $KE = (1/2)mv^2 =$ $(1/2)(74 \text{ kg})(11 \text{ m/s})^2 = 4.5 \times 10^3$ J
4. A stretched bungee cord contains elastic potential energy.
5. In photosynthesis, energy from sunlight is captured by plants and stored in sugars and other organic molecules. The energy is stored in the molecules as chemical energy, which is a form of potential energy.
6. The kinetic energy of an object quadruples when the speed of the object doubles.
7. Mechanical energy is the sum of potential and kinetic energy on a large scale, while chemical energy is not measured on a large scale and has little effect on large-scale systems. Chemical energy is the energy stored in the bonds of a chemical compound.

SECTION: CONSERVATION OF ENERGY

1. Efficiency is a quantity that measures the ratio of useful work output to work input.
2. Mechanical energy can be transformed into nonmechanical energy due to friction or air resistance, which causes an increase in temperature in the system or in the surrounding environment. Mechanical energy can also be transformed into nonmechanical energy when a sound is produced by friction or an impact.
3. **a.** 60%
   efficiency = *useful work output/work input* = (45 N)/(75 N) = 0.60 = 60%
   b. 87%
   efficiency = (39 N)/(45 N) = 0.87 = 87%
   c. 44%
   efficiency = (75 N)(2.5 m)/(425 J) = (187.5 J)/(425 J) = 0.44 = 44%
4. A machine with a high efficiency will transfer a greater amount of the work input to useful work output.
5. With each bounce, some of the ball's mechanical energy is transformed into non-mechanical energy. With less total mechanical energy, the ball cannot bounce as high.
6. At the top of the hill, a skier has mostly potential energy. As the skier glides down the hill, that energy is transformed into kinetic energy, and the skier gains speed. A small amount of the energy may be transformed into nonmechanical energy, which may cause the snow to melt or produce a swooshing sound.

Science Skills

EQUATIONS WITH THREE PARTS

1. 450 N
2. 6

SQUARES AND SQUARE ROOTS

1. 37 m^2
2. 10.51 m
3. 36.4444
4. 12.1

PERCENTAGES

1. 62%; 44%; friend's neighborhood
2. 52%; 49%; ninth grade class
3. $\frac{3}{5}$

Math Skills

WORK

1. $d = \frac{W}{F} = \frac{2.7 \text{ J}}{4.5 \text{ N}} = 0.60 \text{ m}$
2. $d = \frac{W}{F} = \frac{4.35 \times 10^{-2} \text{ J}}{7.25 \times 10^{-2} \text{ N}} = 0.600 \text{ m}$
3. $d = \frac{W}{F} = \frac{8.8 \times 10^{-4} \text{ J}}{3.4 \times 10^{-4} \text{ N}} = 2.6 \text{ m}$
4. $F = \frac{W}{d} = \frac{9.8 \times 10^{7} \text{ J}}{35 \text{ m}} = 2.8 \times 10^{6} \text{ N}$
5. $F = \frac{W}{d} = \frac{405 \text{ J}}{15 \text{ m}} = 27 \text{ N}$

Answer Key

Bellringer Transparencies

SECTION: TEMPERATURE

1. Bowl A would feel cold; bowl B would feel warm.
2. Bowl A would feel warm; bowl B would feel cold.
3. A more effective way to describe the weather would be to give average temperature ranges.

SECTION: ENERGY TRANSFER

1. The tin cup may get hot enough to burn your lips. The hot, fast-moving molecules in the cocoa collide with the atoms in the cup, making them move faster and raising the cup's temperature.
2. The warm air near the candle rises because its molecules move fast and are far apart, so the air is less dense. When the hot, fast-moving atoms and molecules strike molecules in the hand, they transfer energy to it.
3. The radiation from the fire travels in all directions, not just upward.

SECTION: USING HEAT

1. The area near the liquid will get cooler as evaporation occurs.
2. Because the area near the thermostat was cooler due to evaporation, the thermostat signalled the heater to keep running.
3. **a.** no
   b. no
   c. yes
   d. no
   e. yes

Concept Reviews

SECTION: TEMPERATURE

1. Temperature is the measure of average kinetic energy of all the particles in an object. The higher the average kinetic energy, the higher the temperature.
2. The total kinetic energy is the sum of all the kinetic energies for each gas particle in the box. The average kinetic energy is the total kinetic energy divided by the total number of gas particles in the box.
3. As temperature increases, the liquid in a thermometer gains kinetic energy and expands. As the liquid expands, it rises in the tube, indicating a higher temperature. As the temperature decreases, the liquid in the thermometer loses kinetic energy and contracts.
4. **a.** 61°F; $T_F = 1.8t + 32 = 1.8(16) + 32 = 61°\text{F}$ **b.** 35°C; $T_C = \frac{T_F - 32}{1.8} = \frac{95 - 32}{1.8} = 35°\text{C}$ **c.** 243 K; $T = t + 273.15 = -30 + 273.15 = 243\ \text{K}$

   d. −173°C; $t = T - 273.15 = -173°\text{C}$
5. The temperature of the block of iron will decrease and the temperature of the water will increase.
6. The headline is not realistic. Absolute zero (0 K) is the lowest temperature theoretically possible. At absolute zero, all molecular motion stops.
7. The metal will expand when the weather gets hot and the door may get stuck in the frame.

SECTION: ENERGY TRANSFER

1. Ceramic is an insulator and does not conduct heat. Stainless steel is a conductor of heat, so it will conduct heat away from the oatmeal.
2. Radiation—because they are not touching, energy transfer by conduction cannot occur; and because they are in a vacuum, energy transfer by convection cannot occur.
3. **a.** 6.27×10^6 J; energy = (specific heat) × (mass) × (temperature change) = $(4180\ \text{J/kg} \cdot \text{K}) \times 100\ \text{kg} \times (15\ \text{K}) = 6.27 \times 10^6\ \text{J}$

   b. 2.80×10^6 J; energy = (specific heat) × (mass) × (temperature change) = $(1870\ \text{J/kg} \cdot \text{K}) \times 100\ \text{kg} \times (15\ \text{K}) = 2.80 \times 10^6\ \text{J}$

4. The particles in a gas are more spread out than the particles in a liquid and have less attractive forces acting between them; so, if the same amount of energy is transferred to a gas as to a liquid, the kinetic energy of the particles in a gas will increase more than the kinetic energy of particles in a liquid.
5. Convection—movement of the hot water as it expands and rises, then cools and contracts, mixes the hot and cold water.
6. Students should defend their answers. A heavy cast iron skillet transfers heat evenly, resists temperature changes, and is slow to heat. A thin stainless steel skillet transfers heat quickly, has a high surface temperature directly over the flame, and cools quickly.

SECTION: USING HEAT

1. A damp towel has water that absorbs heat energy and evaporates as the air blows through it. Because the air loses heat energy to the water, the air is cooler.
2. **a.** No, the refrigerator releases heat from inside the box out the back of the unit. The refrigerator is in the room, so the heat is still released in the kitchen.
   b. Yes, because shivering causes muscle movements that generate heat
   c. Yes, because the large ears of a jackrabbit act as radiators to radiate heat from the rabbit's blood.
3. The two objects that will be at different temperatures, such as an inside wall and an outside wall, should be separated by an air-filled space so that they are not touching, in order to eliminate heat loss by conduction.
4. A diesel engine does not use spark plugs. Instead, it compresses the fuel-air mixture so much that a spark is ignited.

Math Skills

TEMPERATURE CONVERSION

1. $T_F = 1.8t + 32.0 = (1.8 \times 453) + 32.0$
   $= 847°\text{F}$
   $T = t + 273 = 453 + 273 = 726\ \text{K}$
2. $T_F = 1.8t + 32.0 = [1.8(-235)] + 32.0$
   $= -391°\text{F}$
   $T = t + 273 = -235 + 273 = 38\ \text{K}$
3. $T_F = 1.8t + 32.0 = (1.8 \times 15) + 32.0$
   $= 59°\text{F}$
   $T = t + 273 = 15 + 273 = 288\ \text{K}$
4. $T_F = 1.8t + 32.0 = (1.8 \times 190) + 32.0$
   $T = t + 273 = 190 + 273 = 463\ \text{K}$
   $= 370°\text{F}$
5. $t = \dfrac{(T_F - 32.0)}{1.8} = \dfrac{(125 - 32.0)}{1.8} = 52°\text{C}$
   $T = t + 273 = 52 + 273 = 325\ \text{K}$
6. $t = \dfrac{(T_F - 32.0)}{1.8} = \dfrac{(17 - 32.0)}{1.8} = -8.3°\text{C}$
   $T = t + 273 = 265\ \text{K}$
   $t = \dfrac{(T_F - 32.0)}{1.8} = \dfrac{(83 - 32.0)}{1.8} = 28°\text{C}$
   $T = t + 273 = 28 + 273 = 301\text{K}$
7. $t = \dfrac{(T_F - 32.0)}{1.8} = \dfrac{(-83.9 - 32.0)}{1.8}$
   $= -64.4°\text{C}$
   $T = t + 273 = -64.4 + 273 = 209\ \text{K}$
8. $t = \dfrac{(T_F - 32.0)}{1.8} = \dfrac{(276 - 32.0)}{1.8}$
   $= 136°\text{C}$
   $T = t + 273 = 136 + 273 = 409\ \text{K}$
9. $t = T - 273 = 5100 - 273 = 4800°\text{C}$
   $T_F = 1.8t + 32.0 = 1.8(4800) + 32.0$
   $= 8700°\text{F}$
10. $t = T - 273 = 1088 - 273 = 815°\text{C}$
    $T_F = 1.8t + 32.0 = 1.8(815) + 32.0$
    $= 1.50 \times 103°\text{F}$
11. $t = T - 273 = 3500 - 273 = 3200°\text{C}$
    $T_F = 1.8t + 32.0 = 1.8(3200) + 32.0$
    $= 5800°\text{F}$
12. $t = T - 273 = 240 - 273 = -30°\text{C}$
    $T_F = 1.8t + 32.0 = 1.8(-30) - 32.0$
    $= -20°\text{F}$
13. $T_F = 1.8t + 32.0 = 1.8(29) + 32.0 = 84°\text{F}$
    $T_F = 1.8t + 32.0 = 1.8(-11) + 32.0$
    $= 12°\text{F}$
14. $t = T - 273 = 1.0 \times 10^6 - 273$
    $= 1.0 \times 10^6\text{C}$
15. $t = T - 273 = 4.25 - 273 = -269°\text{C}$
    $T_F = 1.8t + 32.0 = 1.8(-269) + 32.0$
    $= -452°\text{F}$
16. **a.** $\Delta t = \dfrac{(\Delta T_F)}{1.8} = \dfrac{(49°\text{F})}{1.8} = 27°\text{C}$
    b. $\textit{initial } t = \textit{final } t - \Delta t$
    $= 45°F - 49°F = -4°\text{F}$

Answer Key

Bellringer Transparencies

SECTION: TYPES OF WAVES

1. Small concentric circles radiate out from where the rock entered the water. Energy was transferred from the rock to the water.
2. The energy comes from the wave itself. The water wave is energy traveling through the water.
3. The string vibrates back and forth very quickly.
4. The musician touches the cymbals with his or her body to stop the vibration.

SECTION: CHARACTERISTICS OF WAVES

1. Answers will vary but may include AM radio (radio waves), FM radio (radio waves), microwave ovens (microwaves), X rays in medicine (X rays), night-vision goggles (infrared), and telescopes (visible light, microwaves, and radio waves).
2. Answers will vary. A laser is accurately focused to burn away an unwanted area. Blood vessels are sealed in the process due to the intensely focused energy. In this way a patient receives a virtually bloodless surgery.

SECTION: WAVE INTERACTIONS

1. Light waves strike the flat surface of a mirror and bounce back. Since the surface is flat, the light waves are reflected back at equal angles of incidence, producing an image.
2. Answers will vary. The reflection of sunlight off the mirror makes it easier to find a lost hiker.
3. Sound waves are bounced off surfaces, such as walls, buildings, or canyon walls, and are returned, creating an echo.
4. Light waves hit the blinds and are reflected. The angle of reflection of the light waves depends on the angle of the blinds.

Concept Reviews

SECTION: TYPES OF WAVES

1. sound waves—the air; seismic waves—the earth; water waves—the ocean
2. **a.** electromagnetic waves **b.** electric fields and magnetic fields
3. **a.** particles in the medium oscillate perpendicular to the direction the wave travels **b.** particles in the medium oscillate parallel to the direction the wave travels
4. Particles in a medium oscillate, or vibrate back and forth, as a wave passes by. The motion of a particle in a medium is like the harmonic motion of a mass vibrating on a spring.
5. **a.** Wave front A would have the largest height, wave front B would have an intermediate height, and wave front C would have the smallest height. $A > B > C$ **b.** wave front C **c.** Each wave front has the same total amount of energy.

SECTION: CHARACTERISTICS OF WAVES

1. **a.** amplitude **b.** trough **c.** period **d.** frequency **e.** crest
2. **a.** gamma rays **b.** radio waves **c.** radio waves
3. As a source of sound moves toward a person, frequency and pitch increase, wavelength decreases, and wave speed stays the same. As a source of sound moves away from a person, wavelength increases, frequency and pitch decrease and wave speed stays the same.
4. **a.** $f = 2$ Hz, $T = 0.5$ s
   $f = 2$ cycles/s $= 2$ Hz
   $T = 1/f = 1/(2\text{ Hz}) = 0.5$ s
   b. 0.5 m
   $\lambda = v/f = (1\text{ m/s})/(2\text{ Hz}) = 0.5$ m

SECTION: WAVE INTERACTIONS

1. **a.** The waves would bounce, or reflect, off the surface or boundary. Example: light reflecting off a mirror **b.** The waves would bend, or diffract, as they passed the edge or opening. Example: hearing voices outside the doorway of a classroom (sound waves diffract around the doorway) **c.** The waves would bend, or refract, as they passed from one medium to another (unless they met the boundary straight on). Example: a spoon in a glass of water that looks divided in two (light waves from the spoon inside the water are bent when they pass from water into glass, then into air) **d.** The waves would interfere, or be added or subtracted, as they passed through one another. Example: ripples overlapping on the surface of a pond, producing interference patterns.
2. Check students' drawings. Waves that interfere constructively should have crests and troughs lined up with each other, and the resulting wave should be larger than either of the original waves. Waves that interfere destructively should not have crests and troughs lined up, and the resulting wave should be smaller than the larger of the original waves. Use **Figure 20** in the textbook as a reference.
3. 1.0 m

$$\lambda = 1 \text{ wavelength} \left(\frac{1.5 \text{ m}}{1.5 \text{ wavelength}} \right) = 1.0 \text{ m}$$

Math Skills

WAVE SPEED

1. $\lambda = \frac{v}{f} = \frac{3.00 \times 10^8 \text{ m/s}}{9.05 \times 10^7 \text{ Hz}} = 3.32 \text{ m}$

2. $\lambda = \frac{v}{f} = \frac{331 \text{ m/s}}{2.5 \times 10^4 \text{ Hz}} = 0.013 \text{ m}$

3. $\lambda = \frac{v}{f} = \frac{331 \text{ m/s}}{20.0 \text{ Hz}} = 16.6 \text{ m}$

4. $\lambda = \frac{v}{f} = \frac{335 \text{ m/s}}{67 \text{ Hz}} = 5.0 \text{ m}$

5. $\lambda = \frac{v}{f} = \frac{1.45 \times 10^3 \text{ m/s}}{288 \text{ Hz}} = 5.03 \text{ m}$

6. $f = \frac{v}{\lambda} = \frac{346 \text{ m/s}}{2.69 \text{ m}} = 129 \text{ Hz}$

$T = \frac{1}{f} = \frac{1}{129 \text{ Hz}} = 7.75 \times 10^{-3} \text{ s}$

7. $f = \frac{v}{\lambda} = \frac{2.42 \times 10^4 \text{ m/s}}{1.1 \text{ m}} = 2.2 \times 10^4 \text{ Hz}$

$T = \frac{1}{f} = \frac{1}{2.2 \times 10^4 \text{ Hz}} = 4.5 \times 10^{-5} \text{ s}$

8. $f = \frac{v}{\lambda} = \frac{346 \text{ m/s}}{10.6 \text{ m}} = 32.6 \text{ Hz}$

9. $f = \frac{v}{\lambda} = \frac{1.94 \times 10^8 \text{ m/s}}{5.89 \times 10^{-7} \text{ m}} = 3.29 \times 10^{14} \text{ Hz}$

10. $v = f \times \lambda = (60.0 \text{ Hz}) \times (0.90 \text{ m})$
$= 54 \text{ m/s}$

11. $v = f \times \lambda = (60.0 \text{ Hz}) \times (85.5 \text{ m})$
$= 5.13 \times 10^3 \text{ m/s}$

12. $\lambda = \frac{v}{f} = \frac{8.0 \times 10^3 \text{ m/s}}{0.050 \text{ Hz}} = 1.6 \times 10^5 \text{ m}$

13. $f = \frac{v}{\lambda} = \frac{4.5 \times 10^3 \text{ m/s}}{2.3 \times 10^4 \text{ m}} = 0.20 \text{ Hz}$

14. $v = f \times \lambda$
$= (1.5 \times 10^5 \text{ Hz}) \times (1.0 \times 10^{-2} \text{ m})$
$= 1.5 \times 10^3 \text{ m/s}$

15. $f = \frac{v}{\lambda} = \frac{7.0 \text{ m/s}}{14 \text{ m}} = 0.50 \text{ Hz}$

$T = \frac{1}{f} = \frac{1}{0.50 \text{ Hz}} = 2.0 \text{ s}$

One wave reaches the ship every 2.0 s.

Concept Reviews

SECTION: SOUND

1. The speed of sound depends on how often the particles of the medium collide with one another. At higher temperatures, the particles move faster and collide more often.
2. The loudness of a sound depends on the energy contained in the sound waves, which is determined by their amplitude. It also depends on the listener's distance from the source of the sound.
3. The pitch produced by a stringed instrument can be changed by increasing or decreasing the length of the string by moving your fingers to a new position. A shorter length of string vibrates at a higher frequency (pitch), and a longer length of string vibrates at a lower frequency (pitch).
4. The sound from a guitar contains more harmonics than the sound from a tuning fork. A tuning fork vibrates only at its fundamental frequency. A guitar string vibrates at its fundamental frequency and at particular whole-number multiples of that frequency.
5. Sound waves in the air vibrate the eardrum. These vibrations pass from the eardrum to the bones of the middle ear—the hammer, anvil, and stirrup. The stirrup strikes a membrane at the opening of the inner ear, producing longitudinal waves in the cochlear fluid.
6. **a.** 3850 m
   $d = vt = (1540 \text{ m/s})(2.50 \text{ s}) = 3850 \text{ m}$
   b. 1920 m
   $d = (3850 \text{ m})/2 = 1920 \text{ m}$
   (the depth of the water is half the distance traveled by the sound pulse)

SECTION: THE NATURE OF LIGHT

1. Light can be modeled either as a wave or as a stream of particles. Depending on the situation, light seems to behave either like a wave or like a particle.
2. **a.** wave model **c.** particle model
   b. particle model
3. **a.** radio waves **c.** gamma rays
   b. gamma rays **d.** radio waves
4. The photons emitted by a bright light bulb and a dim light bulb of the same color have the same energy (but there are more photons emitted per unit time by the bright light bulb). A blue (higher frequency) light bulb emits higher energy electromagnetic waves than a red (lower frequency) light bulb.
5. radio waves, microwaves, infrared light, visible light, ultraviolet light, X rays, gamma rays
6. X rays are used to produce images of bones and other structures. Gamma rays can be used to treat cancer by killing diseased cells.

SECTION: REFLECTION AND COLOR

1. Light rays striking a rough surface are reflected in many directions, while parallel light rays striking a smooth surface are all reflected in the same direction. Rough surfaces cause diffuse reflection because light rays are reflected in many directions when they hit the uneven surface (the normal to the surface is not always pointing in the same direction).
2. Check students' drawings for accuracy. The angle of incidence and the angle of reflection should appear to be roughly 30°, measured from the normal (perpendicular). The light rays should show directional arrows, and the angle of incidence should lie on the side of the normal where light rays are approaching.
3. Answers may vary. **a.** virtual, stretched **b.** real or virtual, compressed
4. Check students' drawings for accuracy.
5. **a.** yellow **b.** yellow **c.** black, because blue light contains no yellow light

SECTION: REFRACTION, LENSES, AND PRISMS

1. **a.** toward the normal
   b. away from the normal
2. You see a mirage when light is refracted by hot air just above the ground. Your brain may interpret the image of the sky coming from the direction of the ground as a reflection from a pool of water.
3. Total internal reflection occurs when light is completely reflected at a boundary between two transparent mediums because the angle of incidence exceeds the critical angle. Light rays are internally reflected in fiber optic cables, allowing light signals to be transmitted.
4. converging lens—incoming light rays are bent inward by a converging lens
5. **a.** refracts light **b.** acts like the shutter on a camera to allow light to pass through to the lens **c.** refracts light onto the retina at the back of the eye
6. White light is made up of light of different colors. Because light of different colors travels at different speeds in a medium, a prism refracts each color through a different angle. As a result, white light is spread out, or dispersed, into a spectrum of colors.

Science Skills

ANGLES AND DEGREES

1. 30°
2. 50°
3. yes
4. 360°

THE AREA OF A CIRCLE

1. 491 cm^2
2. 200 m^2 (2 significant figures)

EQUATIONS INVOLVING A CONSTANT

1. 4.0×10^{-7} m
2. 170 kg•m/s^2, or 170 N

Concept Reviews

SECTION: ELECTRIC CHARGE AND FORCE

1. Two unlike charges are attracted to each other.
2. The force is four times greater, or quadrupled. Alternatively, the difference in the forces is equal to three times the original force.
3. **a.** conductor **d.** conductor
   b. conductor **e.** insulator
   c. insulator
4. Both charges are positive; the charge on the left is greater.
5. **a.** upward **b.** downward **c.** The electron will have a greater acceleration because it is less massive than the proton.

SECTION: CURRENT

1. There must be a potential difference between the ends of the wire.
2. When an electric device is connected across the terminals of a battery, there is a potential difference across the device and electric charges are accelerated by the electric field in the device.
3. Electric current is the rate at which electric charges move through a conductor. The units of current are coulombs (amount of charge) per second, or amperes.
4. Resistance is due to internal friction slowing the movement of electrons through a conducting material. Resistance can be determined from the ratio of the voltage across a conductor to the current in the conductor using the relationship $R = V/I$.
5. 32 V
   $V = IR = (2.0\text{ A})(16\text{ ohms}) = 32\text{ V}$
6. 1.8×10^{-2} A
   $I = V/R = 12\text{ V}/650\ \Omega = 0.018\text{ A}$
7. Superconductors are materials that have zero resistance when at or below their critical temperature. Conductors are materials in which electric charges can easily be transferred. Insulators are materials in which electric charges are not easily transferred. Semiconductors are between insulators and conductors in their electrical properties.

SECTION: CIRCUITS

1. battery (1); switch (2); resistors (5) (two are light bulbs)
2. The 20-amp fuse would give greater protection because it would melt at a lower value of current.
3. In a series circuit, there is only one path for electric charge. So current is the same everywhere throughout a series circuit. The voltage across each device in a series circuit may be different. In a parallel circuit, there is more than one conducting path. The voltage across each device is the same, but the current in each device can be different.
4. 53 W
   $P = IV = (2.2\text{ A})(24\text{ V}) = 53\text{ W}$
5. 0.33 A
   $I = P/V = (4.0\text{ W})/(12\text{ V}) = 0.33\text{ A}$
6. $3.1 \times 10^2\ \Omega$
   $R = P/I^2 = (45\text{ W})/(0.38\text{ A})^2 = 310\ \Omega$
7. Answers may vary. They are connected in parallel, so they have the same voltage across them; therefore, the resistance of each appliance determines the current in the appliance. Alternatively, if one appliance does not work, the others will still be able to function if they are connected in parallel.

Answer Key

Bellringer Transparencies

SECTION: MAGNETS AND MAGNETIC FIELDS

1. Answers will vary but may include refrigerator magnets, refrigerator door seals, cabinet door latches, compasses, and hand tools.
2. The two magnets will either attract each other or repel each other. A 180° rotation will produce the opposite of the initial result.
3. A compass points to the magnetic north pole, which is near the geographic North Pole, giving a disoriented person a sense of direction.
4. No, the magnetic N pole and geographic North Pole are two different geographic locations. The magnetic S pole is located near the geographic North Pole.

SECTION: MAGNETISM FROM ELECTRIC CURRENTS

1. Answers will vary but may include fans, computers, aquarium pumps, refrigerators, washing machines, hand drills, and electric screw drivers.
2. A shaft in an electric motor is designed so that one magnet is attracted to two other magnets. Two magnets are located opposite each other and their poles are constantly shifted. The magnet located in the center of these two magnets will be initially attracted to one of the magnets and then repulsed because of the pole change. The constant attraction-repulsion of the center magnet will cause the shaft to rotate.
3. The magnetic domains within the needle temporarily align making the needle a temporary magnet.

SECTION: ELECTRIC CURRENTS FROM MAGNETISM

1. Answers will vary but may include CD players, boom boxes, and tape recorders.
2. Answers will vary but may include hairdryers, curling irons, electric razors, and electric fans.
3. The CD player is designed to use direct current. The adapter takes the household alternating current and converts it to direct current.
4. The voltage that goes into a neighborhood is dangerously high for a single home. The voltage must be decreased for safety reasons.

Concept Reviews

SECTION: MAGNETS AND MAGNETIC FIELDS

1. Check drawings for accuracy.
2. 4 north poles, 4 south poles
3. Check drawings for accuracy.
4. Magnetic field strength is greatest near the pole of a magnet and decreases with distance from the pole.
5. You are facing east, because north is on your left.
6. At the north magnetic pole, the compass N pole will point straight down. As you move south, the S pole of the compass will tip forward until the needle is horizontal. It will point almost directly north-south. As you approach the south magnetic pole, the compass S pole will tip forward until it points straight down at the south magnetic pole.

SECTION: MAGNETISM FROM ELECTRIC CURRENTS

1. The current is to the left. Electrons move toward the right.
2. In magnetic materials, not all of the magnetic fields due to the electrons cancel. In nonmagnetic materials, the magnetic fields of the electrons cancel each other.
3. **a.** increases **b.** decreases
4. Domains are microscopic regions composed of atoms whose magnetic fields are aligned. When an unmagnetized metal core is inserted in a solenoid, the domains reorient to align with the external magnetic field due to the solenoid, magnetizing the core.

5. The direction of the current in the coil changes every half revolution so that the loop will rotate in one direction only. If the current in the coil, and therefore the magnetic field, did not change direction every time the coil makes a half revolution, the coil would just bounce back and forth between the poles until friction caused it to come to rest.

SECTION: ELECTRIC CURRENTS FROM MAGNETISM

1. An electric current can be produced in a circuit by a changing magnetic field. This can be accomplished by changing the strength, position, or orientation of an external magnetic field.
2. **a.** increase **b.** decrease **c.** increase
3. As the loop is rotated in the magnetic field, charges in the loop experience a changing force due to the magnetic field. For each half rotation the direction of the magnetic force on the charges changes direction.
4. Electromagnetic waves consist of electric field and magnetic field waves that are perpendicular to each other and to the direction of travel. EM waves can travel through empty space because the changing electric and magnetic fields regenerate each other without the need for a medium.
5. **a.** step-down **b.** step-up **c.** step-down

Cross-Disciplinary

CONNECTION TO SOCIAL STUDIES: THE NATURAL FORCES AND LAWS OF COMPASSES

1. The gyroscopic compass is more susceptible to mechanical failure because it has moving parts.
2. Yes, a gyrocompass is an example of Newton's first law. A magnetic compass is not.
3. A ship with a gyrocompass might need a magnetic compass to set the gyrocompass to point north.

INTEGRATING CHEMISTRY: MOLECULAR MAGNETISM

1. Watermelon. It is a diamagnetic material because it contains water. The others are not.
2. The magnetic force field created by the magnet isn't strong enough to overcome the force of gravity pulling the grape down.
3. No. The direction of the magnetic force must be opposite the force of gravity to keep the object aloft.

INTEGRATING TECHNOLOGY: MAGNETIC RESONANCE IMAGING

1. MRI provides a noninvasive view of internal body tissue.
2. a strong magnetic field
3. The signal of the hydrogen atoms as they move back into alignment after being forced out of alignment by radio waves produces the radio waves that result in an image.
4. Because the metal parts might be attracted to the strong magnetic field, MRI instruments cannot be used on people with metal implants.

Pretest

1. The ions repel each other.
2. The negatively charged object will be attracted to the fixed positively charged object and accelerate toward it. Also, it will have greater electrical potential energy when farther from the positively charged object, and this energy will be converted to kinetic energy as it moves toward the positively charged object.
3. The magnets repel each other.
4. A compass needle points in a certain direction because of the presence of a magnetic field, such as from a magnet or Earth's magnetic field.
5. a
6. b
7. Charges have electrical potential energy as they leave one terminal of the battery, which is converted to kinetic energy as they move through the circuit to the other terminal. Some of the energy is lost as heat or light

Answer Key

Bellringer Transparencies

SECTION: SIGNALS AND TELECOMMUNICATION

1. Answers may vary but may include sending messages by secret codes.
2. A satellite dish is required to collect the wave signal that is transmitted by the satellite.
3. Satellites provide speed, availability, and reliability in our communication system without requiring the use of breakable wires.

SECTION: TELEPHONE, RADIO AND TELEVISION

1. Radios, televisions, and telephones are designed to pick up a particular signal. We can adjust which signal is picked up by changing the channel or tuning the devise.
2. The radio signal becomes unclear when it is not properly tuned in and when it is out of range. Fine tuning the tuning knob may correct the problem.
3. In the early days of the telephone, there were no electronic switches to select the correct phone number being dialed. This had to be done manually by operators.

SECTION: COMPUTERS AND THE INTERNET

1. Answers may vary. The list may include finding books at the library, registering for classes in the counselor's office, checking out of school in the attendance office, making a deposit at the bank, buying food at the grocery store, or researching on the Internet at home.
2. Answers may vary. The list may include MS Word, MS Works, Adobe Illustrator, Math Blaster, and Netscape Navigator.
3. The Internet is a network of computers connected together to exchange information. The Internet provides a low-cost worldwide information-exchange network.
4. Answers may vary. The Internet provides an easy and inexpensive method of sharing resource information, such as research findings.

Concept Reviews

SECTION: SIGNALS AND TELECOMMUNICATION

1. **a.** hand gesture **b.** code
2. electric current, electromagnetic waves
3. b
4. The sound waves cause a membrane inside the microphone to vibrate. This creates an analog signal in the form of a changing electric current.
5. 1—current on, 0—current off
6. Answers may vary. Some common answers include CD, hard-disk drive, and DVD.

SECTION: TELEPHONE, RADIO, AND TELEVISION

1. d
2. The three different types of phosphors give off the three primary colors: red, green, and blue. The three primary colors are sufficient to produce all the remaining colors.
3. c
4. The radio will not be able to pick up a broadcast from any radio stations.
5. The quality of the image becomes better as the number of scan lines increase.

SECTION: COMPUTERS AND THE INTERNET

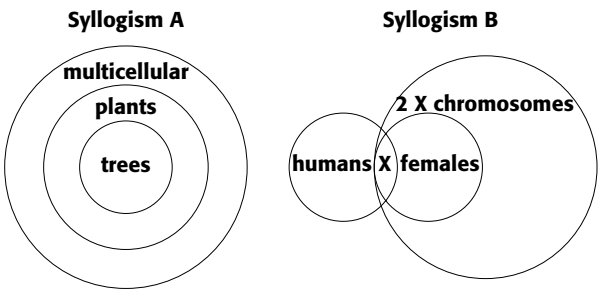
1. **a.** AND gate and OR gate **b.** Check students' drawings for accuracy.
   c. The porch light comes on because the temperature sensor comes on.
   d. An OR gate is not a good choice. The owner of the house should use an AND gate to control the porch light. This way the porch light comes on only when both the temperature increases above 75°F and it is dark outside.

2. **a.** RAM **b.** ROM
3. compact discs (CD-ROMs) and digital versatile discs (DVD-ROMs)
4. A modem is a device that codes the output data of your computer and uses it to modulate a carrier wave that is transmitted over telephone lines; it also extracts data from an incoming carrier wave and sends that data to your computer.

Science Skills

BASIC EXERCISES IN LOGIC

Constructing a Diagram for the Premises



Using the Diagram to Determine the Conclusion

Syllogism A: All trees are multicellular.
Syllogism B: Some humans have two X chromosomes.

Evaluating Other Conclusions

1. cannot determine
2. false
3. cannot determine

Cross-Disciplinary

CONNECTION TO ARCHITECTURE: COMPUTERS AND DESIGN FIELDS

1. slide rule
2. Architects can e-mail important messages and design plans to clients instantaneously.
3. A computer simulation can let the designer know if there are any flaws in the design or miscalculations in the plans of the design. A computer simulation can also help designers, or their clients, to quickly make decisions about the structure, or even the colors, of their products.

CONNECTION TO FINE ARTS: ARTS AND THE INTERNET

1. Three art forms being changed by the Internet are creative writing, music, and visual art.
2. Answers may vary, but students should mention that Internet art museums allow people to view art that they might not get to see otherwise, because it is so far away. Also, Internet art museums allow viewers to view art at any time, rather than only during museum hours.
3. Answers may vary, but students should mention that many unknown bands may want people to hear their music so they can become popular and well-known.

CONNECTION TO SOCIAL STUDIES: MORSE CODE AND COMPUTERS

1. Morse code was invented for the telegraph.
2. Morse code led to the use of paper tape to convey and store information. Paper tape was used in the first computers.
3. Paper tape transmitters use two rows, one for dashes and one for dots. In Morse code, the dashes took three times as long to deliver as the dots; but with the paper tape, they took the same amount of time. Also, since there were two rows on the paper tape, a dot and a dash could be delivered at the same time instead of one after the other.

INTEGRATING BIOLOGY: THE BRAIN'S SIGNALS

1. The function of neurons is to gather, use, and distribute information.
2. Axons are branches that allow one neuron to connect to others.
3. Receptors in the skin gather information such as texture and temperature.

INTEGRATING MATHEMATICS: CONVERTING BINARY NUMBERS

1. 4, 1, 21
2. 11, 10010, 1001101

Answer Key

Bellringer Transparencies

SECTION: SUN, EARTH, AND MOON

1. gravity
2. Answers may vary. Possible answers include: solar eclipses, lunar eclipses, lunar phases, tides.
3. Earth's atmosphere causes weathering of surface. The moon has no atmosphere, and so feature on its surface can remain unchanged for millions of years.
4. Answers will vary. As more is learned about the universe and its contents, certain models must be revised to take this additional knowledge into account. Studying the universe provides information for making such revisions. In addition, some people have the desire to understand how the universe and its contents came to be.

SECTION: THE INNER AND OUTER PLANETS

1. Answers may vary but should include six of the following planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.
2. Answers may vary. The planets are composed of some of the same elements. The inner planets—Mercury, Venus, Earth, and Mars—and Pluto have solid surfaces. The outer planets—Jupiter, Saturn, Uranus, and Neptune—are composed of gases.
3. Answers may vary. Asteroids are small, rocky objects with orbits similar to those of planets. Comets are small, icy objects which mostly originate from the outer edges of the solar system. Meteoroids are tiny, rocky objects that burn brightly when they enter Earth's atmosphere (meteors), and sometimes strike Earth's surface (meteorites). Moons are large, rocky bodies that orbit planets.
4. The orbits mostly lie in the same plane (except for Pluto and Mercury). Distance between planets becomes greater farther from the sun.

SECTION: FORMATION OF THE SOLAR SYSTEM

3, 5, 1, 4, 2

Concept Reviews

SECTION: SUN, EARTH, AND MOON

1. Nine
2. Gravity is the force that keeps planets orbiting stars and satellites orbiting planets.
3. During a lunar eclipse, Earth is between the sun and the moon.
4. The gravitational pull on Earth by the moon causes tides. The attraction is strongest on the side of Earth near the moon. This strong attraction causes water on Earth's surface to move towards the moon, causing a bulge.
5. In order for a solar eclipse to occur the moon's orbit must be exactly lined up in the orbit between the Earth and the sun.

SECTION: THE INNER AND OUTER PLANETS

1. **a.** Jupiter
   b. Pluto
   c. Venus
   d. Uranus
   e. Mars
   f. Neptune
   g. Mercury
   h. Saturn
   i. Earth
2. The inner planets are called terrestrial planets because they have solid, rocky surfaces with distinct geologic features like planet Earth.
3. The hydrosphere helps provide a moderate environment for life. Earth's atmosphere also helps regulate temperature and protects against untraviolet radiation and space objects.
4. The gas giants have thick, gaseous atmospheres, many satellites, and rings.

SECTION: FORMATION OF THE SOLAR SYSTEM

1. Aristotle believed in a geocentric model. Copernicus proposed a heliocentric model but believed the planets orbited in perfect circles, insted of elliptical orbits.
2. The gases and dust condensed approximately 4.6 billion years ago.
3. Objects that orbit in the same direction tend to form from objects spinning in the shape of a disc. Astronomers believe the nebular cloud collapsed into a flat, rotating disc.
4. The gas and dust near the sun did not join together easily causing the planets near the sun to lose their lighter materials, leaving behind rocky planets. The colder gas and dust joined to become the gas giants.
5. While Earth was still in its molten stage, it was struck by a Mars-sized body. A large part of Earth's mantle was blasted into space and along with debris from the impacting body formed the moon.

Science Skills

CLASSIFYING ITEMS

1. Listing Each Category

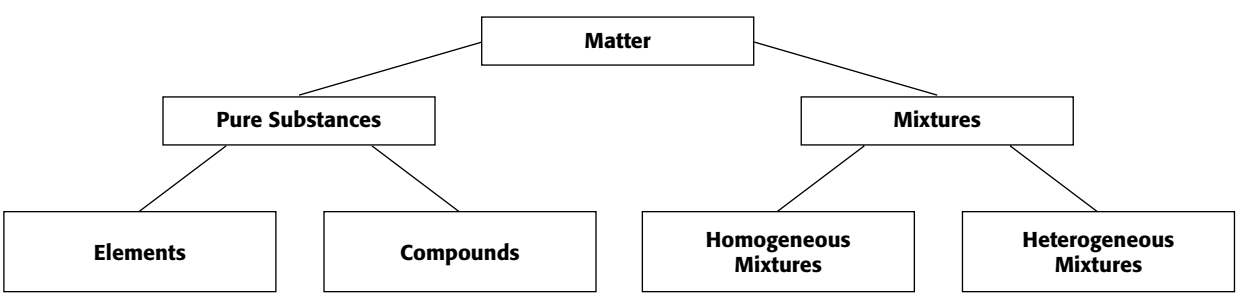
pure substances, mixtures, elements, compounds, homogeneous, heterogeneous

2. Arranging the Categories

Most general categories: pure substances, mixtures

Subdivisions: elements and compounds are pure substances; homogeneous and heterogeneous are types of mixtures

3. Drawing the Diagram



Cross-Disciplinary

CONNECTION TO SOCIAL STUDIES: EGYPTIAN CALENDARS

1. The yearly flooding of the Nile River.
2. The stellar calendar, based on the star Sirius, was 365 days and was used for agriculture; the civil calendar was based on 12 30 day months and used in government business. The lunar calendar was used for religious festivals and every day life and corrected occasionally by adding an extra month.

CONNECTION TO LANGUAGE ARTS: SCIENCE FICTION AND FACT

Students' descriptions of life on a space station in 2075 should suggest reasonable technological advances in meeting human needs in space.

INTEGRATING MATHEMATICS: USING COMPARISONS TO UNDERSTAND SPACE STATISTICS

Answers may vary. Sample answers are given.

1. The moon is less than a third the diameter of Earth.
2. Mercury is less than half the diameter of Earth.
3. Venus is slightly smaller than Earth.
4. Mars is about half the diameter of Earth.
5. Jupiter is about 11 times the diameter of Earth.
6. Saturn is nearly 9.5 times the diameter of Earth.
7. Uranus is about 4 times the diameter of Earth.

Answer Key

Bellringer Transparencies

SECTION: THE LIFE AND DEATH OF STARS

1. Answers may vary. The list may include Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius, Pisces, Cassiopeia, Orion, Ursa Major, and Pegasus.
2. Each type of electromagnetic wave gives additional information about stars. By connecting various pieces of information, a clearer picture of how stars form and evolve emerges.
3. Answers may vary. Some stars are brighter because they are closer, but others are brighter because they are larger or hotter. The colors of stars varies with the temperatures of the stars, just as a red hot metal has a different color than a white hot one. Dust between the star and the observer can also affect the color, just as it affects the color of the sun or moon when they are seen near the horizon.

SECTION: THE MILKY WAY AND OTHER GALAXIES

1. Answers may vary but should include stars and planets. Other items may include comets, asteroids, nebulas, and black holes.
2. Yes, the force of gravity that keeps planets orbiting the sun and which causes stars to contract should also be the force that holds large structures like galaxies together.
3. The components of galaxies move with ordered and predictable motion, regardless of the scale of those components. Planets orbit the sun, and stars orbit the center of the galaxy.
4. The stars in the "Milky Way" region of our galaxy, and especially in other galaxies, are too distant to be seen clearly as points of light. They appear instead as a milky haze. Distant galaxies (as well as glowing gaseous regions within our galaxy) also have the appearance of clouds, hence the term "nebulas."

SECTION: ORIGINS OF THE UNIVERSE

1. Answers may vary but could include stars, planets, comets, asteroids, black holes, and galaxies. The students may also include the names of individual heavenly bodies.
2. The same elements should be found throughout the universe because all of the components of the universe began from the same source. The abundance of these elements would probably vary, as they do within the soloar system's planets.
3. As in the case of stars, each type of electromagnetic wave gives additional information about the universe itself. By connecting various pieces of information, a clearer picture of how the universe formed emerges.
4. The speed of light is finite, so the farther an object is from us, the longer it takes light from it to reach us. The light from a galaxy that we see today left that galaxy millions of years ago, so what we see now occurred long ago. In this way, we look "back in time."

Concept Reviews

SECTION: THE LIFE AND DEATH OF STARS

1. Hydrogen and helium
2. One star may appear brighter than another for any of the following reasons: it is actually hotter and brighter than the other star; it is larger than the other star; it is closer to Earth than the other star.
3. All stars emit light across a wide range of wavelengths, but the wavelength at which it emits the most light depends on the surface temperature of the star. That wavelength also determines the observed color of the star.

4. Stars are driven by nuclear fusion reactions, which release a tremendous amount of energy. This energy slowly works its way out through the layers of a star until it is finally released as starlight.
5. The sun formed from a cloud of gas and dust collapsing under its own weight. When the center of the cloud became dense enough, nuclear fusion started in the core, and the sun was born. The sun will continue fusing hydrogen into helium for billions of years. When fusion of hydrogen into helium stops, the sun will become a red giant, fusing helium into carbon and oxygen. When fusion of helium into heavier elements stops, the sun will become a white dwarf and eventually burn out completely.
6. The energy produced by nuclear fusion in the core of a star pushes outward, counteracting the force of gravity pulling inward.
7. Nuclear fusion in the cores of stars combines lighter nuclei into heavier nuclei, creating the heavier elements. Most stars spend most of their lives fusing hydrogen into helium. Red giants can create elements as heavy as oxygen, and supergiant stars can create elements as heavy as iron. Elements heavier than iron can only be created in supernovas, the explosions that occur when supergiant stars die.

SECTION: THE MILKY WAY AND OTHER GALAXIES

1. A galaxy is composed of stars, dust, and gas.
2. Check students' drawings of the Milky Way galaxy. Drawings should show at least one of the following features: spiral arms; a flat disk; a central bulge.
3. Interstellar matter is the gas and dust that exists in the space between the stars.
4. Spiral and elliptical galaxies have fixed shapes. Spiral galaxies have spiral arms with young stars and interstellar matter, and a huge bulge of old stars in the center. Elliptical galaxies resemble spiral galaxies without the spiral arms. Irregular galaxies are of variable shape and star composition.
5. Quasars are the most distant and radiant objects in space.

SECTION: ORIGINS OF THE UNIVERSE

1. empty space
2. Red shift is an apparent shift toward longer wavelengths by a luminous object moving away from the viewer; blue shift is an apparent shift toward shorter wavelengths by a luminous object moving toward from the viewer.
3. Almost all other galaxies have red shifts. Therefore, most other galaxies are moving away from the Milky Way galaxy (and each other), and implies that the universe is expanding.
4. The big bang theory theorized that all matter and energy in the universe was compressed into an extremely small volume that exploded and began expanding in all directions 10 to 20 billion years ago.
5. The universe will expand forever, stop expanding and start to contract, or gradually slow (but never quite stop) expanding.
6. Dark matter is part of the composition of the universe, currently undetectable by normal means. The total amount of dark matter in the universe affects the total mass of the universe, a direct factor in the fate of the universe.

Science Skills

SECTION: RATIOS AND PROPORTIONS

1. 6 cups of water
2. 21 male teachers
3. $x = 600$
4. 12 miles
5. 24 beakers

Cross-Disciplinary

CONNECTION TO SOCIAL STUDIES: ANCIENT CHINESE ASTRONOMY

1. The Chinese emperors traditionally reported activities occuring in the heavens to the people. Over time, the tradition became a notable discipline.

Answer Key

Bellringer Transparencies

SECTION: EARTH'S INTERIOR AND PLATE TECTONICS

1. The outer layer of the peach is thin and relatively hard, like Earth's crust.
2. The pulp is softer and part liquid, just like the somewhat molten mantle.
3. Like the pit, Earth's core is solid and dense.

SECTION: EARTHQUAKES AND VOLCANOES

1. The pressure inside the bottle will increase.
2. Eventually the pressure exceeds the force of the bottle's walls causing the bottle to explode.
3. When the holt molten material breaks through the crust, one possible result is a volcano.

SECTION: MINERALS AND ROCKS

Granite: large crystals, light color
Basalt: small crystals, dark color
Obsidian: hard, dark, glasslike, no obvious crystal structure, dark color
Sandstone: fine-grained with layers, small crystals, light color

SECTION: WEATHERING AND EROSION

1. A wave has energy that allows it to move sand as it rolls onto a beach.
2. The Colorado River made the Grand Canyon by weathering away the land over time.
3. Answers may vary but may include ice, wind, plants, and chemicals.
4. Potholes form in the road as a result of continuous wearing by cars and trucks.

Concept Reviews

SECTION: EARTH'S INTERIOR AND PLATE TECTONICS

1. **a.** continental crust **d.** mantle
   b. oceanic crust **e.** outer core
   c. lithosphere or crust **f.** inner core
2. Check students' drawings for accuracy. Divergent plate boundary drawings should show plates moving apart. Convergent plate boundary drawings should show plates moving toward each other. Transform boundary drawings should show plates moving horizontally past each other.
3. **a.** volcanoes, mountains, ocean trenches
   b. ocean trenches, volcanoes
4. Magnetic bands in oceanic rocks have alternating polarities, demonstrating that Earth's magnetic field reverses about every 200 000 y. These bands are symmetrical to the Mid-Atlantic ridge with the youngest rocks near the center of the ridge. This indicates that the rocks had changed position after cooling, supporting plate tectonics theory.

SECTION: EARTHQUAKES AND VOLCANOES

1. **a.** Primary waves which are longitudinal seismic waves **b.** Secondary waves which are transverse seismic waves **c.** seismic waves that move along Earth's surface
2. A seismograph has a pendulum with a pen at its tip that touches a piece of paper on a rotating drum. When the ground shakes, the rotating drum vibrates under the pendulum and the vibrations are recorded as lines on the paper.
3. As plates shift with respect to each other, their edges experience a great deal of pressure. This stress eventually becomes so great that it breaks rock along the fault, causing an earthquake.
4. Shield volcanoes produce gently sloping mountains from typically mild, recurrent eruptions of lava. Cinder cones tend to have short, violent eruptions of ash and chunks of lava and then become dormant, producing hills with steep sides.
5. Volcanoes form at divergent plate boundaries because as the plates move apart magma rises to fill the gap. At convergent boundaries, magma

rises to the surface from the subducting plate to form volcanoes.

SECTION: MINERALS AND ROCKS

1. naturally occurring, nonliving, with a definite chemical composition that can be expressed with a chemical formula, with a characteristic internal structure
2. **a.** igneous **b.** sedimentary **c.** metamorphic
3. **a.** form from compressed or cemented deposits of sediment, older rocks, and organisms: limestone, conglomerate **b.** form when a rock is subjected to high pressure and heat and undergoes a chemical change: marble, slate
4. An igneous rock can break down due to weathering. The weathered particles can be carried away by water and wind and deposited, and eventually cemented together to form a sedimentary rock.
5. The oldest fossils are at the bottom of the cliff because those rocks were deposited first. Over time, new rock layers are deposited on top of older rock layers. The youngest fossils are at the top of the cliff in the most recently deposited rocks. Answers may refer to the principle of superposition.
6. The absolute age of a rock can be found by determining the ratio of the amount of the product of a radioactive material's decay to the amount of the original radioactive material in the rock. The amount of time that passed since the rock formed can be calculated based on this ratio.

SECTION: WEATHERING AND EROSION

1. **a.** wind, water, ice, plants **b.** acid rain, CO_2 dissolved in water
2. **a.** erosion **c.** physical weathering **b**. erosion **d.** erosion
3. Physical weathering breaks rocks into smaller pieces without changing the rocks' chemical composition. Chemical weathering breaks rocks down by changing their chemical composition.
4. Some carbon dioxide dissolves in rainwater, producing an acidic solution. This acidic rainwater reacts with calcite from the limestone to form calcium bicarbonate. This compound dissolves in the water and is carried away, leaving a void.
5. Carbon dioxide from the air dissolves in rainwater, forming acidic rainwater that chemically weathers calcite out of limestone to form caves. Acid rain from pollution can weather and erode metal and rock.
6. In weathering, rocks are broken down by either chemical or physical means without being removed. In erosion, rocks and the products of weathering are removed.

Science Skills

1. GATHERING THE EVIDENCE

Some students may have additional items circled here. They should eliminate any such irrelevant facts or opinions in parts two and three.

A. A bowling ball falls to Earth much faster than a feather.

C. In a vacuum, where there is no air resistance, a bowling ball and a feather dropped together have the same speed at any given height.

E. Air resistance depends on the shape of an object.

G. A crumpled-up sheet of paper falls to Earth faster than a flat sheet of paper.

2. CLASSIFYING THE EVIDENCE

Student classifications may vary in this chart, depending on their level of understanding at this point. The following is an example, but other variations are possible. All variations should be corrected in part three.

Answer Key

Bellringer Transparencies

SECTION: CHARACTERISTICS OF THE ATMOSPHERE

Answers will vary but should reflect that this is an exercise in creative writing. Some students may know more about the greenhouse effect than others. Accept paragraphs with evidence of creative ideas about the differences in Earth's conditions as a result of significantly higher or lower temperatures. Dramatic increases or decreases in temperature would affect Earth's climate, changing weather patterns by bringing droughts to some areas and floods to others. A significant increase in temperature could cause icecaps to melt and ocean levels to rise. A significant decrease in temperature could cause the formation of even larger icecaps. Geological aspects of Earth would change as a result of changes in weathering. Encourage students to imagine ways that plant and animal life on Earth would adapt to changes in temperature by evolving to withstand the extreme heat or cold.

SECTION: WATER AND WIND

1. Barometer (b) has a higher column due to greater atmospheric pressure.
2. Barometer (a) is likely to be at the top of a mountain (lower pressure) and (b) at sea level (higher pressure).
3. Atmospheric pressure increases as altitude decreases. Barometer (a) measures a lower atmospheric pressure than barometer (b), so barometer (a) is more likely to be at the top of a mountain.

SECTION: WEATHER AND CLIMATE

1. Yes. The longer days occur because the Northern Hemisphere faces toward the sun, leading to hotter days.
2. Answers may vary. Climate descriptions should be general rather than specific.
3. Mountains can block winds and can force moist air upward, causing precipitation.

Concept Reviews

SECTION: CHARACTERISTICS OF THE ATMOSPHERE

1. Nitrogen (about 78 percent) and oxygen (about 21 percent).
2. Check students' diagrams. Refer to **Figure 1.**
3. The increased carbon dioxide might increase plant growth because plants use carbon dioxide in photosynthesis.
4. CFCs react with ozone and convert it to oxygen. With less ozone, the amount of ultraviolet radiation that reaches the Earth's surface increases.
5. In a temperature inversion, cool air becomes trapped beneath warm air. In Los Angeles, a temperature inversion would cause pollutants to be trapped in the cool air, causing heavy smog.
6. The troposphere has its warmest temperatures at the bottom and is cooler closer to the top. The stratosphere is coldest at its base and gets warmer with increasing altitude.

SECTION: WATER AND WIND

1. **a.** Evaporation is the process by which water molecules escape from liquid water and rise as gaseous water vapor.
   b. Humidity is the quantity of water vapor in the atmosphere.
   c. Precipitation is any form of water (rain, snow, sleet, or hail) that falls back to Earth's surface from clouds.
2. Check students' drawings. Refer to **Figure 12.**
3. Air moves, in the form of wind, from areas of high pressure to areas of low pressure.
4. Winds in the Northern Hemisphere curve to the right, and winds in the Southern Hemisphere curve to the left.
5. Humidity is the quantity of water vapor in the atmosphere. Relative humidity is a ratio of the quantity of water vapor present in the atmosphere to the maximum quantity of water vapor that can be present at that temperature.

SECTION: WEATHER AND CLIMATE

1. Go to a storm cellar or basement. If no cellar or basement is available, get under a table away from windows. If you are outside, lie in a ditch or low-lying area, and cover your head with your hands.
2. Check students' drawings. Earth should be tilted on its axis so that the Southern Hemisphere is toward the sun.
3. Weather is a description of what is happening in the atmosphere. Climate is an average of weather over a long period of time.
4. In a thunderstorm, water droplets and ice crystals in thunderclouds build up electrical charges. When the charge in a thundercloud becomes different enough from the charge in another cloud or on Earth's surface, lightning jumps as a big spark to equalize the charge.
5. In a cold front, cold air moves quickly under warm air causing warm air to rise rapidly. In a warm front, cold air is slowly overrun by warm air.

Cross-Disciplinary

CONNECTION TO LANGUAGE ARTS: THE LAYERS OF THE ATMOSPHERE

1. The highest layer of the atmosphere is the thermosphere.
2. The name stratosphere is derived from the Latin word "stratus," and the Greek word "sphaira."
3. All the layers of the atmosphere have "sphaira" as their base because each of them is shaped like a ball (or sphere) that surrounds Earth.

INTEGRATING CHEMISTRY: CLOUD SEEDING

1. Three substances commonly used for cloud seeding are sodium chloride (salt crystals), hydrogen chloride, and water sprays.
2. Cloud seeding can be used to try to reduce the number of lightning strikes during a thunderstorm.
3. Students should mention that substances are introduced into the cloud that increase the chance that the water droplets will begin to bind to each other, creating bigger drops and possibly rain.

INTEGRATING HEALTH: WHY YOUR EARS POP

1. You would develop an earache whenever you changed your altitude because of the pressure.
2. Under water, the pressure outside the eardrum is greater than that inside the eardrum.
3. It would be pressed towards the outside. The greater pressure on the inside would push into the area of lesser pressure, and the eardrum would be pushed out.

INTEGRATING PHYSICS: ADOBE

1. Adobe soil is a mixture of clay, sand, and silt.
2. Good heat conductors allow energy to flow very quickly when there is a temperature difference, while good heat insulators do not.
3. Metals are very good heat conductors, so a house with metal walls would not be energy efficient. In the summer the house would warm up too quickly and in the winter it would cool down too quickly.

INTEGRATING PHYSICS: THE TROPOPAUSE

1. The troposphere
2. Answers may vary, but they should contain a description similar to the following: Part of a fluid, such as air or water, is heated. As the fluid is heated, it expands, and decreases in density. Because the heated portion of the fluid is less dense than the unheated portion, the force of gravity causes the heated portion to rise. As it rises, it transfers energy to previously unheated areas.
3. Yes. The water on the bottom of the pan gets warmer and moves to the top of the pan. When the hot water moves up, it carries the heat with it and distributes it throughout the water.
4. The height of the tropopause would

Concept Reviews

SECTION: ORGANISMS AND THEIR ENVIRONMENT

1. Answers may vary. The living elements of an ocean reef ecosystem include the coral creatures that build the reef, fish, and any other creatures that live on the reef. Nonliving elements include sunlight, the reef, ocean water, and gases dissolved in the water.
2. The elements that make up an ecosystem function together (are interrelated) to keep the entire system stable, so a change in one feature can affect the whole system.
3. **a.** short **b.** long **c.** long **d.** short
4. Short-term, long-term
5. Answers may vary. Possible answers include clearing trees, driving cars, and constructing buildings.
6. To evaluate the effects of their decisions on the issues that cause change in their environment, people must first understand how the many parts of an ecosystem relate to one another.
7. Major projects, such as building a dam, must undergo an environmental analysis by engineers before construction begins.

SECTION: ENERGY AND RESOURCES

1. photosynthesis
2. Fossil fuels come from fossilized plant and animal remains that are dug from the ground. solid–coal, liquid–oil, gas–natural gas
3. burning fossil fuels, hydroelectric dams, nuclear power plants
4. **a.** fission and fusion **b.** fission **c.** the disposal of highly radioactive waste
5. **a.** non-renewable, advantage: inexpensive, disadvantage: polluting **b.** renewable, advantage: non-polluting, disadvantage: not efficient in all parts of the world **c.** renewable, advantage: non-polluting, disadvantage: not efficient at all times and places **d.** renewable, advantage: cheap energy, disadvantage: destroys natural environment, only usable for a limited amount of time because dams silt up
6. 1/4

SECTION: POLLUTION AND RECYCLING

1. Postal deliveries of the bill are eliminated—so fuel is not consumed (pollutants are not emitted). Paper envelopes used in mailings are eliminated—so the production of paper products (a very costly and polluting industry) is reduced.
2. **a.** The combustion of fossil fuel produces carbon dioxide, a greenhouse gas. The continual buildup of greenhouse gases causes an increase in Earth's temperature.
   b. Weather patterns could change, bringing droughts to some areas and floods to others. The level of the sea could rise as polar ice melts.
3. It makes water acidic; this can harm or even kill aquatic life. It makes soil even more acidic; this can damage large tracts of forests and harm or kill life in the soil.
4. industrial waste, agricultural fertilizers, and everyday human activities
5. Many land-based pollutants do not dissolve well in water, making them very difficult to remove.
6. reducing use of energy and products (using fabric grocery bags, lowering thermostats), reusing products whenever possible (reusing plastic or paper grocery bags), recycling (aluminum cans, car parts)