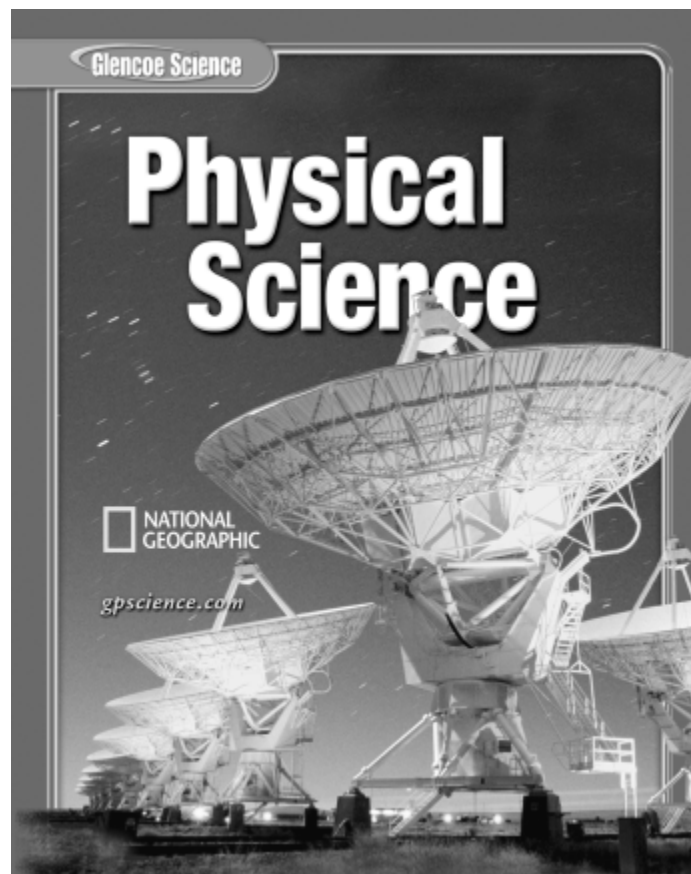


Study Guide and Reinforcement

Answer Key

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To the Teacher

Study Guide and Reinforcement booklet provides an additional resource for reviewing the concepts of the chapter. There is one worksheet for each section, or lesson, of the chapter. The *Study Guide* worksheets are designed to focus primarily on science content and less on vocabulary, although knowledge of the section vocabulary supports understanding of the content. The worksheets are designed for the full range of students.



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ANSWER KEY

Chapter 1

Section 1

1. scientia
2. knowledge

Answers 3 and 4 are interchangeable.

3. observation
4. investigation
5. overlap
6. explanations
7. technology
8. modified

Answers 9, 10, and 11 are interchangeable.

9. life science; living things
10. earth science; Earth and space
11. physical science; matter and energy
12. investigations
13. scientific method
14. dependent
15. constant
16. bias

Section 2

- | | |
|-------------|---------------|
| 1. length | 13. kg, mg |
| 2. time | 14. s |
| 3. kilogram | 15. km, m, cm |
| 4. kelvin | 16. a |
| 5. m | 17. a |
| 6. kg | 18. b |
| 7. s | 19. b |
| 8. K | 20. a |

- | | |
|--|-------------------------------|
| 9. m^3, cm^3 | 21. b |
| 10. mL, cm^3 , L | 22. a |
| 11. $\text{g}/\text{cm}^3, \text{kg}/\text{m}^3$ | 23. volume = 6 cm^3 |
| 12. K, $^{\circ}\text{C}$ | |

Section 3

1. line graph
2. temperature vs. time for heating of water
3. time
4. horizontal or x -axis
5. vertical or y -axis
6. circle graph
7. the percentage of elements making up living things
8. oxygen
9. bar graph
10. the height of students in Sarah's class
11. 168 cm

Chapter 2

Section 1

1. the total number of m, km, or other distance units that are traveled in total; no; $d = st$
2. the distance from a start point to an end point, with a direction; yes; no formula
3. the total distance traveled in a time interval divided by the time interval; no; $s = d/t$
4. the speed at a certain instant in time; no; no formula
5. the speed with the direction of travel; yes; $s = d/t$ can be used, and a direction added

ANSWER KEY

6. the point from which the location of other objects is determined; it sets the direction for other things; no formula

Answers 7–9 are interchangeable.

7. the car can turn a corner
8. the car can accelerate
9. the car can brake
10. If the object changes direction but stays at a constant speed it will have a different velocity.
11. The object is speeding up or slowing down (changing speed, because the slope of the line represents speed).

Answers 12–14 are interchangeable and may vary.

12. 11.2 km/s; rocket; km; s
13. 100 km/h; car; km; h
14. 5 cm/yr; geological plates; cm; years

Section 2

1. Acceleration is the rate of change of velocity.
2. It accelerates when it changes its speed and/or direction.
3. Positive acceleration occurs when an object's speed increases; negative acceleration occurs when an object's speed decreases.
4. change in velocity (final velocity minus initial velocity) divided by time
5. meters/second/second; meters/second²
6. acceleration
7. $a = (v_f - v_i)/t = (9 \text{ m/s} - 3 \text{ m/s})/3\text{s} = 2 \text{ m/s}^2$
8. positive
9. negative
10. zero

Section 3

1. Force is a push or a pull that one object exerts on another.
2. Answers will vary. Examples might include fingers on pencil; body on chair; feet on floor; atmosphere on body.
3. The direction of the motion will change in the direction of the force.
4. It is the net force.
5. The forces are balanced.
6. The forces acting on the rock are not balanced; the net force is not zero.
7. It is the tendency of an object to resist any change in its motion.
8. Velocity changes when the object speeds up, slows down, or changes direction.
9. Its mass determines its inertia.
10. An object moving at constant velocity continues to move at that velocity until a net force acts on it.

Chapter 3

Section 1

1. $a = F/m$
2. $F = ma$
3. the kinds of surfaces and the forces pressing the two together
4. prevents two surfaces from sliding past each other
5. opposes the motion of two surfaces sliding past each other; slows down moving objects
6. frictional force between a rolling object and the object it rolls on; slows down rolling objects

ANSWER KEY

- opposes the motion of objects that move through the air, is affected by speed, size, and shape
- net force
- microwelds
- rolling
- air resistance
- acceleration
- sliding
- parachute

Section 2

- Gravity is a force that every object in the universe exerts on every other object.
- their masses and the distance between them
- Earth has more mass than the Moon.
- No. The Moon exerts a smaller gravitational force than Earth. Weight is the measure of the force of gravity on an object; therefore, an object would weigh less on the Moon.
- friction between the road and the car's tires
-



- Acceleration is a change in the speed or direction of a moving object. When the car changes direction to round the curve, it is accelerating.

Section 3

1.

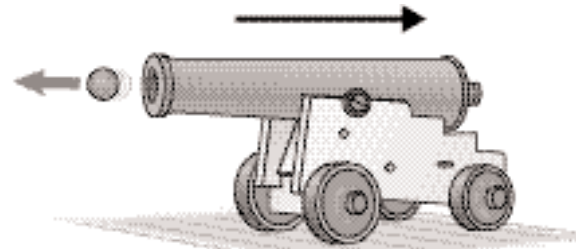


Figure A

2.

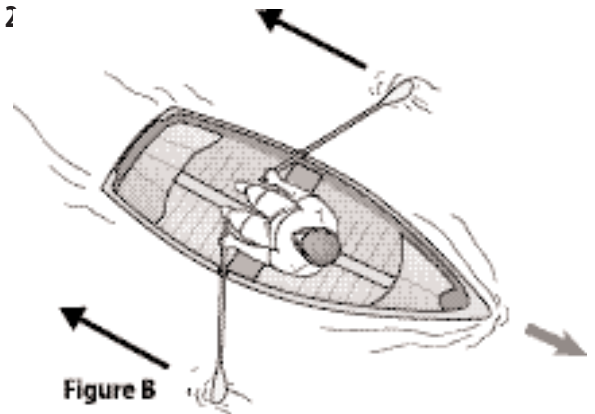


Figure B

- reaction force
- action force
- The force also will be 500 N because action-reaction forces are equal and opposite.
- $p = m \times v = 2 \text{ kg} \times 10 \text{ m/s} = 20 \text{ kg} \cdot \text{m/s}$
- $p = m \times v = 2000 \text{ kg} \times 10 \text{ m/s} = 20,000 \text{ kg} \cdot \text{m/s}$
- the 2000-kg truck because it has a greater mass

Chapter 4

Section 1

- energy
- potential
- kinetic
- gravitational
- speed

ANSWER KEY

6. chemical
7. mass
8. height
9. joule
10. natural gas
11. elastic
12. $KE = 1/2mv^2$; mass, velocity
13. $PE = mgh$; mass, gravity, height

Section 2

Note: Students' answers may be more or less complex than those given.

1. Electrical energy changes to thermal energy.
2. Light energy changes to thermal energy.
3. All of the energy used in the body comes from the food we eat.
4. Chemical potential energy from the waiter's food changes into kinetic energy of motion, and electrical energy changes into light energy.
5. Chemical potential energy from the swallow's food changes to kinetic energy causing vibrations that result in sound. The sound energy changed to kinetic energy in the listener's eardrum, which changes to electrical energy before reaching the listener's brain.
6. Chemical potential energy in the jet fuel changes to thermal energy, which powers the engine. The thermal energy changes to both kinetic and potential energy as the plane takes off.
7. Gravitational potential energy becomes kinetic energy.

8. Chemical potential energy in the place kicker's food changes to mechanical energy in the legs, which changes to kinetic and potential energy in the football.
9. Kinetic energy changes to thermal energy as a result of friction between the runner and the ground.
10. The mass of the fuel is changed into thermal energy, which is converted to mechanical energy.

Chapter 5

Section 1

1. For work to be done on an object, an applied force must make an object move in the same direction as the applied force. An example of work being done is lifting a stack of books. An example of work not being done is carrying a stack of books at a constant waist height.
2. $W = F \times d$
3. $P = W/t$
4. $P = E/t$
5. distance
6. power
7. power
8. work
9. force
10. work and energy
11. power
12. work
13. power

ANSWER KEY

Section 2

1. F_e the force applied to a machine
2. F_r the force applied by the machine to overcome the resistance
3. MA the number of times a machine multiplies the effort force (or $MA = F_r/F_e$)
4. $\text{efficiency} = (W_{\text{out}}/W_{\text{in}}) \times 100\%$ or $\text{efficiency} = (F_r/F_e) \times 100\%$
5. $MA = 500\text{N}/250\text{N}$
 $MA = 2$
6. Accept any two: Machines make work easier by increasing the effort force or by increasing the distance over which a force can be applied or by changing the direction of the effort force.
7. Instead of pushing up on the box top to remove it, the crowbar allows the carpenter to push down.
8. Ideal mechanical advantage is the mechanical advantage of a machine if none of the work input was lost to friction and changed into heat energy.

Section 3

1. d
2. e
3. f
4. a
5. b
6. c
7. g
8. pulley; wheel and axle; lever; gear

9. wedge; screw; inclined plane
10. $IMA = l/h = 3\text{m}/1.5\text{m} = 2$
11. $IMA = L_e/L_r = 10\text{ m}/10\text{ m} = 1$
12. $IMA = r_w/r_a = 4\text{cm}/1\text{cm} = 4$

Chapter 6

Section 1

1. temperature
2. faster
3. kinetic energy
4. potential energy
5. thermal energy
6. collisions
7. warmer
8. cooler
9. heat

Answers may vary as students may have combined steps differently.

10. The mass of the material is measured.
11. The initial temperature of water in the calorimeter is measured.
12. The material is heated and its temperature is measured.
13. The sample is placed in the water in the inner chamber of the calorimeter.
14. The sample cools and transfers its heat to the water, so the water increases in temperature until the sample and the water are at the same temperature.
15. The final temperature of the water is measured, and the change in thermal energy of the water can be calculated.

ANSWER KEY

Section 2

1. good
2. conduction
3. radiation
4. true
5. true
6. true
7. convection
8. convection
9. true
10. more
11. absorbed
12. more
13. a silver spoon; Silver is a better conductor of heat than wood.
14. a red shirt; Darker-colored materials absorb more heat than lighter-colored materials.
15. a sidewalk in the sun; Dull materials absorb more radiant energy than shiny materials.
16. single-pane window; Air between the two panes of glass in the double-pane window acts as insulation.
17. R-5 insulation; Materials with a lower R-value are less resistant to heat flow.

Section 3

1. steam-heating
2. by burning a fuel
3. external
4. by conduction and convection
5. to keep the steam from losing thermal energy
6. by conduction

7. by conduction
8. It condenses into water.
9. by convection

Chapter 7

Section 1

1. negative
2. positive
3. created
4. destroyed
5. neutral
6. electrons
7. transferred
8. static electricity
9. distance
10. amount of charge
11. electric field
12. insulator
13. conductor
14. electric force
15. grounding
16. charging by induction
17. lightning

Section 2

1. more
2. higher, lower
3. volts
4. lose
5. varies
6. amperes

ANSWER KEY

7. electrons
8. positive, negative
9. positive
10. 120 volts
11. wet
12. ohms
13. lower
14. $I = V/R$
15. Ω
16. amperes
17. volts
18. +
19. lesser
20. thinner

Section 3

- 1a. series circuit
- b. parallel circuit
- c. the current has only one loop to flow through
- d. the current has more than one branch
- 2a. insulation to melt
- b. a fire
- c. fuses
- d. circuit breakers
- 3a. rate at which electrical energy is converted to another form of energy
- b. watt
- c. W
- d. kilowatt
- e. kW

- f. power = current \times voltage difference
- g. $P = I \times V$

Chapter 8

Section 1

Answers 1 and 2 are interchangeable.

1. Students should draw or describe two magnets end-to-end with north poles facing each other.
2. Students should draw or describe two magnets end-to-end with south poles facing each other.

Answers 3 and 4 are interchangeable.

3. Students should draw or describe two magnets end-to-end with the north pole on the first magnet facing the south pole on the second magnet.
4. Students should draw or describe two magnets end-to-end with the south pole on the first magnet facing the south pole on the second magnet.
5. in Northern Canada, about 1,500 km from the geographic north pole
6. by measuring magnetism in rocks
7. circulation of molten iron and nickel in Earth's outer core

8. north
9. south
10. toward
11. away
12. strong

Section 2

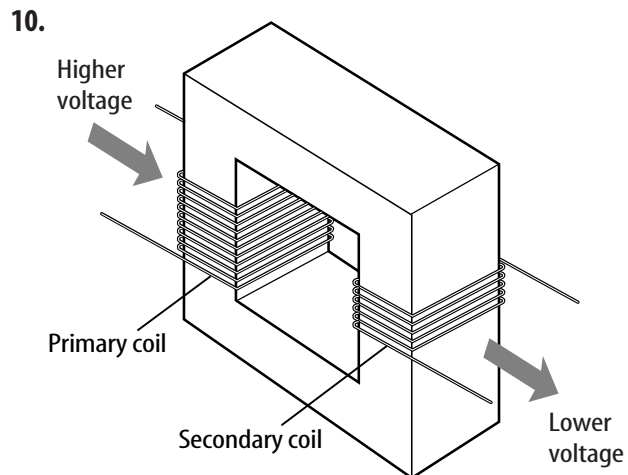
1. an electromagnet
2. temporary
3. increases

ANSWER KEY

- increases
- mechanical
- a galvanometer
- electrical
- an electromagnet
- reversing the direction of current
- commutator
- stronger
- electric current
- Answers can include (but are not limited to) stereo speakers, anything that uses an electric motor, gauges on the dashboard of a car, an alternator in a car, electric lights, spark plugs in a car, generators in an electric power plant, and a model railroad transformer.

Section 3

- permanent magnet
- electromagnet
- source of mechanical energy
- generator
- generator
- alternating
- uses
- transformer
- step-up



Chapter 9

Section 1

- biomass and others 3%
- hydroelectric 4%
- nuclear 8%
- natural gas 23%
- coal 23%
- petroleum 39%
- Fossil fuels are a nonrenewable resource. As fossil fuels are used, the global supply of fossil fuels decreases. As the supply decreases, the cost of obtaining the remaining fossil fuels will increase, which will make fossil fuels more expensive.
- Burning natural gas produces more energy per kilogram of fuel than burning coal or oil.
- Burning natural gas produces no ash and fewer pollutants.
- All fossil fuels are nonrenewable resources, so they are being used up much faster than they are being produced by natural processes.

ANSWER KEY

11. Burning any fossil fuel produces carbon dioxide, and increases the carbon dioxide concentration of the atmosphere. Increasing atmospheric carbon dioxide might cause global climate to warm.
12. Energy cannot be created or destroyed. It can only be transformed converted from one form to another
13. When electric energy flows through power lines, about 10% is lost as thermal energy to the atmosphere.
14. transform one form of energy to another form that can perform a useful function.
15. natural gas

Section 2

- 1a. 5
 - b. 1
 - c. 3
 - d. 7
 - e. 2
 - f. 6
 - g. 4
2. Uranium must be mined from Earth. The mining of uranium causes environmental damage.
 3. Unlike the burning of fossil fuels, the use of radioactive substances to produce electricity does not cause air pollution.
 4. Radioactive wastes may have very long half-lives. If a waste is to be stored in a container, the container must be made in such a way that it will last the duration of the period of radioactive decay.

5. The temperature required to carry out a nuclear fusion reaction is too high for the reaction to be carried out in a laboratory.
6. The products of a fusion reaction are not radioactive. The products of a fission reaction are radioactive.

Section 3

- 1a. energy from the Sun
 - b. a device that converts solar energy into electricity
- 2a. electrical energy produced from the kinetic energy of moving water
 - b. Once a dam is built to harness the water, the cost of electricity is relatively cheap.
- 3a. energy generated by the tidal motion of the oceans
 - b. Only a few places have enough difference between high and low tide to be able to use this as a source of energy.
- 4a. a windmill
 - b. Only a few areas have a consistent wind that can be relied on to generate electricity.

Chapter 10

Section 1

1. mechanical
2. air
3. vibrates
4. energy
5. wave
6. sound
7. medium
8. water wave

ANSWER KEY

- transverse
- earthquake
- compressional
- light
- Water does not actually move with the direction of the water waves. The water moves up and down but does not travel sideways. The disturbance transfers energy to nearby water molecules, which in turn transmit energy by colliding with the molecules around them, and these transfer energy to their neighbors, and so on.
- Wind causes ripples on the ocean. As the ripples increase in size, they provide more and more surface area for the force of the wind to act upon. The highest and steepest waves break up at the top, forming white-caps. Short-wavelength waves will break up and disappear. Long-wavelength waves continue to grow. When the wind dies down, the waves lose energy and become lower and smoother until they become long swells.

Section 2

- crest
- trough
- amplitude
- wavelength
- possibilities are frequency, wavelength, amplitude, and speed
- The frequency is the number of waves that pass a given point in a second. The unit is hertz.
- The wavelength decreases.
- Measure the distance between two wave crests; Measure the distance between a crest and the rest position.

- Measure the distance between two compressions; Measure the density of the medium at a compression.
- $v = \lambda = 6 \text{ Hz} \times 2 \text{ m} = 12 \text{ m/s}$

Section 3

- Reflection of sound waves produces an echo.
- The angle of incidence equals the angle of reflection.
- Both phenomena are caused by the bending of waves. Refraction is caused by waves bending because they change speed when passing from one medium to another. Diffraction is caused by waves bending around a barrier.
- The light wave is bent toward the normal to the surface.
- The tree is large compared to the wavelength of light, so the light rays are not diffracted.
- When they meet, the waves interfere to form a new wave.
- A standing wave is produced when two waves of equal wavelengths and amplitudes, traveling opposite directions, continuously interfere with each other.

Chapter 11

Section 1

- When the speaker cone moves outward, it pushes molecules of air together, and produces a compression. The compression travels outward as molecules of air collide with each other. When the speaker cone moves inward, it produces a rarefaction that travels outward. As the cone moves back and forth, it produces a series of compressions and rarefactions that travel outward, forming a sound wave.

ANSWER KEY

2. Moon
3. atmosphere
4. compressions
5. rarefactions
6. faster
7. solids
8. molecules
9. at the same speed
10. more slowly
11. temperature
12. the outer ear
13. eardrum
14. middle ear
15. cochlea

Section 2

1. The amplitude is shown by the density of the particles in the compressions and rarefactions.
2. Both intensity and loudness are related to the amount of energy a wave carries. Intensity is the amount of energy that flows through a certain area in a given time. Loudness is the human perception of sound intensity.
3. The greater the amplitude, the more energy a wave carries. The greater the energy, the greater the intensity and the louder the sound. The unit of intensity is the decibel.
4. Both are out of the normal hearing range. Ultrasound has frequencies above 20,000 Hz. An example is the sounds emitted by bats in echolocation. Infrasound has frequencies below 20 Hz. Earthquakes and heavy machinery vibrate at these frequencies.

5. As the train approaches, the pitch rises because the sound waves are pushed closer together and the frequency increases. When the train passes the pitch drops because the sound waves are more spread out and the pitch is lower.
6. frequency
7. Hz
8. sound intensity
9. dB
10. a measure of how many wavelengths pass a particular point each second

Section 3

1. resonance
2. brass and wood winds
3. beat
4. vibration
5. noise
6. quality
7. strings
8. fundamental frequency
9. music
10. percussion
11. overtones
12. resonator

Section 4

1. It is the study of sound.
2. Reverberation is an echoing effect caused by many reflections of sound. A gym has many hard surfaces, such as the floor and walls, that would cause many confusing and unpleasant echoes that would interfere with the music.

ANSWER KEY

- The engineer would consider the size and shape of the hall as well as the coverings of the surfaces. She would cut down reverberations by choosing soft, porous coverings for the walls and ceilings and thick carpets for the floor.
- Echolocation is the process of emitting sound and interpreting the sound that is reflected back. A bat emits very high frequency sounds that hit anything in its path. By interpreting the echo, the bat can recognize insects, tell where they, and how fast and in what direction they are moving.
- Sonar is a form of echolocation that uses the reflection of underwater sound waves to detect objects.
- High frequency sound waves are bounced off various internal organs in a patient's body, and the reflections are interpreted by a computer to produce sonograms.
- Ultrasound is better for producing images of soft tissue in the body. X rays are better for examining bones and lungs, because hard tissue and air absorb ultrasonic waves instead of reflecting them.
- Ultrasound is less invasive, and recovery is quicker than from surgery.

Answers 4–8 may vary and are interchangeable. Accept all reasonable answers.

- They are produced by something that vibrates.
- They carry energy from one place to another.
- They move through matter.
- Without matter to transfer energy, they cannot move.
- space
- matter
- electric
- magnetic
- charge
- moving
- create
- perpendicular
- outward
- direction
- transverse
- radiant
- motion
- particles
- photons

Chapter 12

Section 1

Answers 1–3 may vary and are interchangeable. Accept all reasonable answers.

- talking on a cordless telephone or cell phone
- using a microwave
- watching television

Section 2

- a. 2
- b. 4
- c. 7
- d. 1
- e. 3
- f. 6
- g. 5

ANSWER KEY

2. b
3. a
4. b
5. d
6. d
7. a
8. b

Section 3

1. The signal leaves the transmitter as an electromagnetic radio wave. It is detected by the metal antenna of your radio. The vibrating electrons in the antenna create an electric signal. The signal goes through an amplifier and then to the speakers. The amplified signal causes the speakers to vibrate and create a sound wave that travels to your ear.
2. A carrier wave is the electromagnetic wave on which a radio station broadcasts. A different frequency is assigned for each station. The information a station broadcasts is sent to listeners by modifying its carrier wave.
3. Amplitude modulation and frequency modulation are both ways a carrier wave can be modified to carry information. An AM radio station modifies the carrier wave by varying its amplitude. AM carrier frequencies range from 540 to 1600 kilohertz. FM broadcasting stations vary the frequency of the carrier wave. FM frequencies range from 88 to 108 megahertz.
- 4A. Cathode; emits electrons
- B. electromagnets; focus on the electron beam
- C. coated screen; forms picture when struck by electrons

5. The phone transmits on one frequency and receives on another.
6. The Global Positioning System is a system of satellites, ground monitoring stations, and receivers that can provide a person's latitude, longitude, and altitude. Ships, airplanes, and cars can use the system.
7. The long distances covered by the signal cause inconvenient delays in a conversation.

Chapter 13

Section 1

1. incidence
2. transparent
3. prism
4. translucent
5. reflection
6. opaque
7. violet
8. normal
9. refraction
10. image
11. refraction
12. densities
13. cooler
14. Parallel light rays will strike a rough surface at many different angles, and therefore reflect at many different angles. A sharp image will not be formed.

ANSWER KEY

Section 2



Section 3

1. Accept all reasonable paragraphs that use the listed words.
2. Fluorescent lights are more likely to be used in stores and offices, incandescent lights are used more extensively in homes.
3. In general, incandescent lights give a more pleasant and warmer color of light than do fluorescent lights. However, some fluorescent lights have special colors and are more like incandescent lights. Depending on the size of the bulb, both types of bulbs can give out plenty of light.
4. For home use, the color of the incandescent bulb is softer and has a warmer feel. Also, most home lamps are designed for incandescent bulbs. For business use, fluorescent lights are cooler and use far less energy. When a large number of fixtures are in use, the cost of lighting a facility becomes a major consideration.

Section 4

1. Light that reflects off of nonmetallic surfaces becomes polarized in the same plane as the reflecting surface and is called glare. When fishing, you are surrounded by a source of glare that makes it hard to see the fish. Nonpolarizing sunglasses do not reduce the glare and may change the colors of the surroundings making it difficult to work with the fishing equipment.
2. The light beam in the scanner is actually a laser. Looking directly into a laser can burn the interior of your eye. Since the light is focused, it would burn only a small spot, but it would still cause irreversible damage.
3. Optical fibers rely on total internal reflection to transmit light. Therefore optical fibers treat light the way plumbing treats water. Tubes that carry water are called pipes, so the term has been borrowed for light.
4. Pair A is best suited because the vertical polarizing filter blocks horizontally polarized light which is what composes much of the glare from horizontal surfaces. Pair C would be good for viewing 3-D movies.

Chapter 14

Section 1

1. light ray
2. optical axis
3. light source
4. concave
5. plane mirror
6. focal point
7. enlarged
8. diverge
9. convex

ANSWER KEY

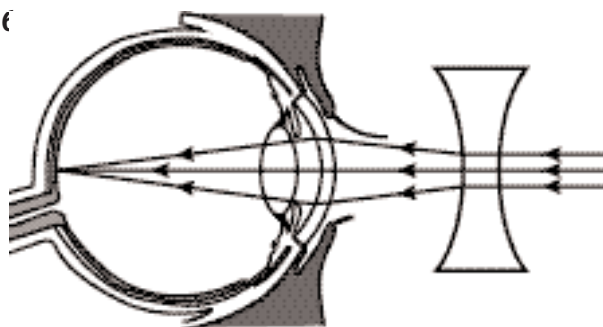
10. real image
11. focal length
12. virtual image
13. students should copy Figure 4, page 18 or draw something very similar

Answers to 14 may vary.

14. flashlights, makeup mirrors, car headlights

Section 2

1. concave
2. refract
3. convex
4. retina
5. behind



Section 2

- 1a. convex lens; convex lens
- b. concave mirror; plane mirror; convex lens
- c. convex lens; convex lens
- 2a. aperture
- b. lens
- c. shutter
- d. film
3. Student answers will vary. Accept all reasonable paragraphs.

Chapter 15

Section 1

1. mixture
2. compound
3. lead
4. substance
5. solution
6. soft drink
7. homogeneous
8. titanium
9. chlorine
10. sodium
11. heterogeneous
12. tungsten
13. A light beam is invisible when shone through a solution. However, when you shine a light beam through a colloid, the light scatters and you can see the beam. This is called the Tyndall effect.

Section 2

1. ice
2. burning
3. condensation
4. combustible
5. air
6. iron
7. burning logs
8. wire
9. A physical change does not change the composition of a material; a chemical change does.

ANSWER KEY

- color, shape, size, melting point, boiling point
- Because of the law of conservation of matter, a pile of ashes retains the mass of the original piece of wood because the ashes, gasses, and smoke released during burning add up to the same mass as the original log.
- Answer will vary. Physical: chipping wood, cutting paper, etc; chemical: burning a pan, having a fire, roasting marshmallows, etc.
- the point at which the bonds of the solid are broken and the molecules can slip past each other; requires an input of energy equal to a substance's heat of fusion
- the amount of energy required to melt a substance; molecules gain enough kinetic energy to break their solid intermolecular bonds
- molecules slipping past each other; particles cling together, giving a definite volume, but they have enough kinetic energy so that they don't have rigid intermolecular bonds
- a gas takes the volume and shape of its container; molecules have a lot of kinetic energy and are far apart
- vaporization that occurs at the surface of a liquid and can occur below the liquid's boiling point; particles at the surface of the liquid have enough kinetic energy to jump into the gas phase
- the point at which the pressure of the vapor in the liquid is equal to the pressure acting on the surface of the liquid, it requires for the liquid to be at a temperature equal to its boiling point and for the input of an amount of energy equal to the heat of vaporization; molecules throughout the liquid are bubbling into the gas phase and rise to the surface to escape
- the amount of energy required for a liquid at boiling point to become a gas; the molecules are escaping from the liquid phase into the gas phase
- spreading of particles through a given volume until they're uniformly distributed; particles move and collide with each other until they hit the walls of their container

Chapter 16

Section 1

Answers 1–3 are interchangeable.

- All matter is composed of small particles.
- These particles are in constant random motion.
- These particles are colliding with each other and the walls of their container.

Answers 4–16 may vary. Students may copy diagrams out of the text or their notes. Accept all reasonable sketches, and correct errors or misconceptions in these sketches.

- total energy of a material's particles, including KE and PE; molecules vibrate and move (KE), and forces act between molecules to hold them together (PE)
- energy of motion; molecules rotate, vibrate, and translate (move)
- energy due to position or bonding; molecules get PE by being near or bonded to other molecules
- measured by temperature, it is the average movements of molecules of a substance; molecules are vibrating
- molecules are closely packed and often geometrically arranged; molecules are rigidly bonded and vibrate in place

ANSWER KEY

- matter consisting of positively and negatively charged particles; the molecules have so much kinetic energy that they collide and knock the electrons off each other
- an increase in the size of a substance when the temperature is increased; molecules increase in kinetic energy and vibrate more, moving farther apart. This decreases density
- water expands as it freezes due to the strong attraction of its polar molecules; this decreases its density and allows ice to float on lakes, which is important for the life of fish
- solids that soften and turn into a liquid over a temperature range instead of at one specific point; molecules gradually overcome their intermolecular bonding to slip past each other, their molecules have no particular ordered arrangement

Section 2

- gas
- an upward
- less than
- true
- Pascal's
- decreases
- true
- The liquid cannot be further compressed and thus can be used to transfer pressure effectively throughout the system. Because a gas is highly compressible, it would not be suitable for use in this device.

- The weight of the displaced water is equal to the weight of the portion of the wood block that is submerged. According to Archimedes' principle, the buoyant force on an object in a fluid is equal to the weight of the fluid displaced by the object.
- The downward force decreases. The lifting force increases. Bernoulli's principle states that as the velocity of a fluid increases, the pressure exerted by the fluid decreases.

Section 3

- Boyle's law states that if you decrease the volume of a container of gas, the pressure of the gas will increase, provided the temperature does not change.
- Charles's law states that the volume of a gas increases with increasing temperature, provided the pressure does not change.
- Pressure is the amount of force exerted per unit of area.
- Absolute zero is the theoretical temperature at which a gas would have a volume of zero. This temperature is 273°C , or 0 K .
- The pressure will increase.
- The pressure will increase.
- 273 K
- 373 K
- freezing point = 0°C , boiling point = 100°C

ANSWER KEY

Chapter 17

Section 1

1. bubble chamber
2. particle accelerator
3. Democritus
4. Aristotle
5. electron cloud
6. Thomson
7. orbits
8. Dalton
9. atom
10. Rutherford
11. quark
12. Chadwick
13. Dalton's model: it was corrected by adding charged particles inside
14. Thomson's model: it was corrected by adding a nucleus
15. Rutherford's model: it was corrected by adding energy levels
16. Bohr's model: it was corrected by giving the electrons clouds of probability instead of little orbit tracks to run on

Section 3

1. atomic number
2. element
3. chemical symbol
4. average atomic mass
5. groups (or families)
6. electrons
7. properties
8. periods
9. metals
10. transition elements
11. nonmetals

Section 2

1. Isotopes are atoms of the same element that differ only in the number of neutrons in their nucleus.
2. The isotope boron-10 has one less neutron than boron-11.
3. The average atomic mass of an element is the average mass of the mixture of its isotopes.
4. The two chlorine isotopes have the same number of protons in their nuclei and the same number of electrons around their nuclei. However, chlorine-37 has two more neutrons in its nucleus than does chlorine-35.
5. Because these isotopes occur in equal parts in nature, the average atomic mass will be simply an average of the three atomic masses. Therefore, the average atomic mass will be 204 amu.

ANSWER KEY

Chapter 18

Section 1

Answers 1–3 are interchangeable.

1. repulsive
2. greater
3. long
4. strong
5. short
6. neighbors
7. protons
8. radioactive
9. synthetic
10. ninety two
11. unstable

Answers 12–14 are interchangeable.

12. number of protons
13. number of electrons
14. chemical properties

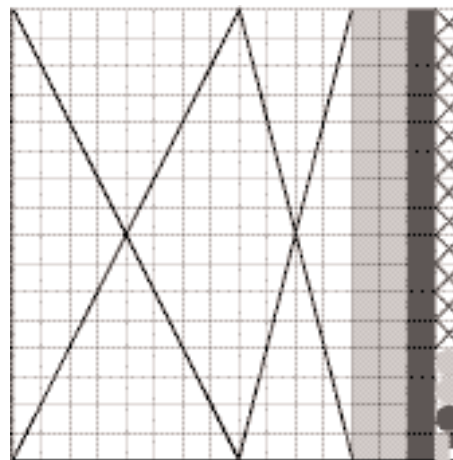
Answers 15–16 are interchangeable.

15. number of neutrons
16. mass number

Answers 17–19 are interchangeable.

17. Henri Becquerel
18. Marie Curie
19. Pierre Curie

Section 2



1. 128 g
2. 64 g
3. 32 g
4. 16 g
5. 8 g
6. 4 g
7. 2 g
8. 1 g
9. 0.5 g
10. 0.25 g

Students' bar or line graphs should show a steep decline from 260 g to 4 g, then a leveling off through 0.25 g.

ANSWER KEY

Section 2

1. shiny; dull
2. yes; no
3. yes; no
4. yes; no
5. yes; no
6. solid; gas
7. yes; no

NOTE: for questions 8–14, answers may vary. Accept all correct responses.

8. gas, forms diatomic molecules, highly reactive
9. active gas, forms diatomic molecules, 7 electrons in outer energy level
10. gas, forms diatomic molecules, 7 electrons in outer energy level
11. liquid at room temperature, 7 electrons in outer energy level
12. shiny, gray solid, sublimates, 7 electrons in outer energy level
13. 2 electrons in outer energy level, not reactive, gas
14. 8 electrons in outer energy level, not reactive, gas
15. Bromine is the only nonmetal that is a liquid at room temperature.
16. Hydrogen is the only nonmetal on the left side of the periodic table.

Section 3

1. aluminum, gallium, indium, thallium, tin, lead, bismuth
2. boron, silicon, germanium, antimony, tellurium, polonium, arsenic

3. carbon, nitrogen, phosphorus, oxygen, sulfur, selenium
4. When neptunium falls apart, it forms plutonium, which is used in nuclear reactors and bombs and is changed into americium for use in smoke detectors.
5. Forms of the same element that have different molecular structures.
6. One is hard, gray substance. The other is a brown powder.
7. diamond, graphite, buckminsterfullerene

Chapter 20

Section 1

1. lose 1
2. lose 3
3. gain 2
4. gain 3
5. none
6. gain 4
7. gain 3
8. lose 2
9. gain 1
10. compounds
11. properties
12. color
13. gain
14. lose
15. stable
16. nearest
17. formula
18. force
19. outer

ANSWER KEY

Section 2

- 1a. 2
 - b. 2
 - c. 2+
 - d. 2-
 - e. 0
 - f. ionic
2. The groups in the periodic table are organized by the number of electrons in the outermost energy level of the atoms. For example, all of the elements in Group I have one electron in that energy level.
 3. Atoms gain or lose electrons to other atoms; Atoms share electrons.
 4. ions; molecules
 5. solid; liquid or gas

Section 3

1. An oxidation number is a positive or negative number that tells how many electrons an atom must gain, lose, or share to become stable.
2. 2-; 1+
3. zero
4. $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ has six molecules of water attached to the cobalt chloride. Anhydrous cobalt chloride, CoCl_2 , does not have any water attached to it.
5. 1+
6. 2+
7. 2-
8. 1-
9. 0
10. CuSO_4
11. CuCl_2

12. FeO
13. Cu_2O
14. Na_2S
15. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
16. ammonium hydroxide, 7
17. ammonium chloride, 6
18. silver oxide, 3
19. potassium sulfate, 7
20. calcium nitrate, 9
21. sodium sulfide, 3

Chapter 21

Section 1

1. Chemical
2. reactants
3. baking
4. breathing
5. processed
6. industrial
7. alchemy
8. reactants
9. products
10. conservation
11. created
12. destroyed
13. Lavoisier
14. himself
15. combustion
16. respiration
17. metabolism
18. development

ANSWER KEY

19. nomenclature
20. IUPAC
21. equations
22. symbols
23. easier

Answers 24–26 are interchangeable and may vary.
Accept reasonable answers.

24. iron
25. aluminum
26. copper

Section 2

1. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
2. According to the law of conservation of mass, matter cannot be created or destroyed. Therefore, in a chemical equation, the sum of the reactants must equal the sum of the products.
3. $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{aq})$
4. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
5. $2\text{Li}(\text{s}) + \text{FeBr}_2(\text{aq}) \rightarrow 2\text{LiBr}(\text{aq}) + \text{Fe}(\text{s})$
6. $2\text{Al}(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow 2\text{AlCl}_3(\text{aq}) + 3\text{H}_2(\text{g})$
7. $6\text{Li}(\text{s}) + \text{N}_2(\text{g}) \rightarrow 2\text{Li}_3\text{N}(\text{s})$

Section 3

1. e
2. a
3. d
4. b
5. c
6. synthesis reaction
7. single-displacement reaction

8. double-displacement reaction
9. decomposition reaction
10. synthesis reaction
11. decomposition reaction
12. double-displacement reaction
13. decomposition reaction
14. single-displacement reaction
15. double-displacement reaction
16. synthesis reaction
17. double displacement reaction
18. single displacement reaction
19. combustion or synthesis reaction

Chapter 22

Section 1

1. solution
2. polar
3. solvent
4. heating
5. crushing
6. solute
7. water
8. alloy
9. stirring

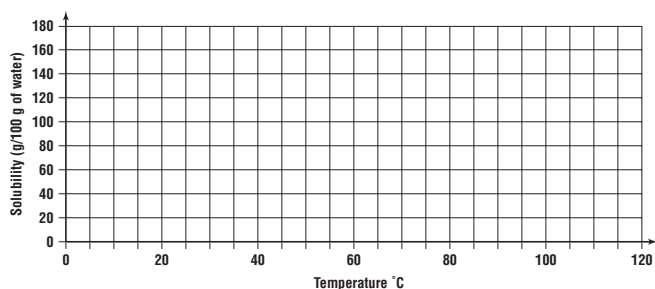
Answers 10–14 are interchangeable and may vary.
Accept all reasonable answers.

10. nitrogen; oxygen (argon, carbon dioxide, etc.); atmospheric air
11. copper; tin; bronze
12. silver; copper; sterling silver
13. water; carbon dioxide (etc.); soda pop
14. water; salts; the ocean

ANSWER KEY

- Water molecules move in on the sugar molecules and the negative (oxygen) ends of the water molecules are attracted to the positive (hydrogen) ends of the sugar molecules.
- Water molecules pull the sugar molecules into solution.
- Both types of molecules mix evenly.

Section 2



- about 73°C
- about 27°C
- unsaturated
- saturated

Section 3

- Ionization; When hydrochloric acid dissolves in water, H₂O molecules surround and pull apart the HCl molecules to form chloride and hydrogen ions, which are shown here as hydronium ions (H₃O⁺) to emphasize the role water plays in ionization.
- a charged particle that can conduct electricity
- an electrolyte
- yes; the hydronium ions (H₃O⁺) have a positive charge, and the chloride ion has a negative charge.

Section 4

- Water is sometimes referred to as the universal solvent because it is a small molecule and can fit easily among the molecules of many solutes.
- Nonpolar materials have no separated positive and negative areas.
- Carbon and hydrogen atoms share electrons in a nearly equal manner.
- Nonpolar molecules such as oil, iodine, and nail polish do not dissolve easily in water.
- Ethanol can dissolve iodine as well as water because it has a polar end and a nonpolar end.
- A general statement describing what dissolves what is the phrase “like dissolves like.”
- When working with nonpolar solvents, good ventilation is important, because nonpolar solvents tend to evaporate more readily than water, producing high concentrations of vapor.
- Fat-soluble vitamins such as Vitamin A can accumulate in our tissues and can be toxic in high concentrations.
- Water-soluble vitamins such as Vitamin C can be flushed out of the body before they can be used and therefore must be replaced constantly.
- Water molecules are attracted by and cling to molecules of polar solutes, making them sticky and slowing evaporation.

Chapter 23

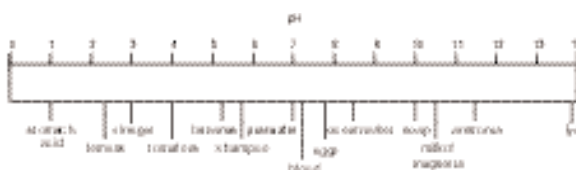
Section 1

- base
- digestion
- dissociate
- hydroxide ion

ANSWER KEY

5. ammonia
6. hydronium ion
7. drain cleaner
8. acids
9. indicator
10. phosphoric acid, carbonic acid
11. sulfuric acid, nitric acid, phosphoric acid, hydrochloric acid
12. ammonia, sulfuric acid, phosphoric acid, nitric acid
13. feel slippery, taste bitter, turn litmus paper blue, are corrosive, produce hydroxide ions in solution
14. are corrosive, taste sour, react with metals to produce hydrogen gas, produce hydronium ions in solution, turn litmus paper red
15. acetic acid, acetylsalicylic acid (aspirin), ascorbic acid (vitamin C), phosphoric acid, carbonic acid

Section 2



1. lemons, stomach acid
2. vinegar, shampoo, tomatoes, bananas
3. soap, blood, ocean water, eggs
4. ammonia, lye, milk of magnesia
5. neutral
6. The pH of a strong acid is lower than that of a weak acid.
7. The pH of a strong base is higher than that of a weak base.

8. The pH of acids is less than 7; the pH of a base is greater than 7.

Section 3

1. Answers may vary. The difference between detergents and soaps is that detergents can be used in hard water.
2. Salts are made from bases, and esters come from alcohols that are not bases but have a hydroxyl group.
3. Polyesters are synthetic fibers that are made from an organic acid that has two $-\text{COOH}$ groups and an alcohol that has two $-\text{OH}$ groups.
4. Titration is a process in which a solution of a known concentration is used to determine the concentration of another solution.
5. The endpoint of titration occurs when a drop of base turns the acid solution pink and the color persists.
6. Answers may vary. Soap has a polar end that mixes easily with oil dirt.
7. During a neutralization reaction, hydronium ions from an acid combine with hydroxide ions from a base to produce water and a salt.
8. A salt is a compound formed when the negative ions from an acid combine with the positive ions from a base.
9. In titration, the solution of known concentration is called the standard solution.

Chapter 24

Section 1

1. millions
2. hydrogen
3. oxygen

ANSWER KEY

4. few
5. thousands
6. fuels
7. medicines
8. dyes
9. plastics
10. textiles
11. bonding
12. covalent
13. single
14. double
15. triple
16. chains
17. branched chains
18. rings
19. saturated
20. multiple
21. isomers
22. 4
23. 10
24. 0
25. 1830
26. 100.7

Section 2

1. +
2. -
3. -
4. +
5. +
6. -

7. C, D
8. An oxygen atom shares a double bond with a carbon atom that has an -OH group attached to it.
9. B, E, F
10. They all contain one or more -OH groups attached to a carbon atom.
11. A
12. CH₃OH
13. B, C, D, E, F
14. F
- 15.



16. C₆H₆

Section 3

1. b
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. d

Section 4

1. protein
2. lipid
3. protein

ANSWER KEY

- protein
- protein, nucleic acid, carbohydrate, lipid
- nucleic acid
- nucleic acid
- protein
- carbohydrate
- protein
- nucleic acid
- carbohydrate
- protein
- carbohydrate
- carbohydrate
- lipid
- protein
- protein, nucleic acid, carbohydrate
- nucleic acid
- protein, nucleic acid, carbohydrate, lipid

Chapter 25

Section 1

Answers may vary. Accept all reasonable answers.

Answers 1–5 are interchangeable.

- malleability; jewelry
- conductivity of heat; cooking pots
- conductivity of electricity; electrical wires
- luster/reflectivity; solar ovens
- Tigris-Euphrates
- 3500 B.C.
- Sumerian
- bronze
- properties

- copper
- tin
- alloys
- titanium
- space ships
- steel
- foods
- fly
- Alloys that are heat-resistant and strong that may be useful for space applications. An example is titanium alloy panels devised for the space shuttle.

Section 2

- coating on blade
- tiles on heat shield
- transparent, conductive material embedded in windshields
- baseball bats, golf clubs, tennis rackets
- resist dulling
- protects against the heat of reentry into Earth's atmosphere
- protects against fogging and icing
- lightweight and absorb vibration
- a material made from metallic elements and oxygen, molded and heated to high temperatures
- It has made it possible for electronic devices to be smaller, cheaper, and capable of more advanced functions.
- extremely dense internal structure
- tooth replacements and braces

ANSWER KEY

13. when they are dropped or when the temperature changes too quickly or drastically
14. An n-type semiconductor has an overall increase in electrons and a p-type has an overall decrease in electrons from doping.

Section 3

1. true
2. polymer
3. synthetic
4. polymer
5. true
6. true
7. monomers
8. plastics
9. fossil fuels
10. glass fibers
11. true
12. composite
13. made up of two or more parts, one embedded in the other
14. Plastics are made from petroleum products, so increased use of plastics increases the amount of fossil fuels used.
15. Answers will vary; They may include reinforced bridges (stronger), fiberglass auto panels (lighter weight, more flexible), aircraft windshields (reduced fogging/icing), satellites (lighter weight, so less expensive to launch), etc.