Chapter 1 Introduction to Physical Science

Chapter 1 Performance Assessment

1. The manipulated variable is temperature; the responding variable is volume of gas.
2. The slope is 0.2 mL/°C.
3. Two data points are above the line, and one data point is below the line.
4. A line of best fit emphasizes the overall trend shown by the data as a whole.
5. As the temperature increases, the volume of gas increases.
6. 62 mL

Chapter 1 Test A

1. a
2. c
3. b
4. c
5. d
6. a
7. b
8. b
9. c
10. d
11. physics
12. controlled
13. Mass
14. Reproducibility
15. line of best fit
16. true
17. hypothesis
18. manipulated variable
19. true
20. true
21. Draw the axes. Label the axes. Create a scale. Plot the data. Draw a line of best fit. Add a title.
22. The horizontal axis, or *x*-axis, is labeled with the name of the manipulated variable, including units of measurement. The vertical axis, or *y*-axis, is labeled with the name of the responding variable, including units of measurement.
23. Draw a smooth line that reflects the general trend of the data points. Drawing a line that connects all the data points plotted on a graph places too much emphasis on each measurement and may not show the general trend.
24. alcohol = 0.787 g/cm^3; corn syrup = 1.38 g/cm^3; cooking oil = 0.926 g/cm^3
25. **a.** alcohol
b. cooking oil
c. water
d. corn syrup
26. Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence they gather. Scientific inquiry does not always occur in the same way. But the typical stages in the process are posing questions, forming a hypothesis, designing an experiment, collecting and interpreting data, drawing a conclusion, and communicating ideas and results.
27. If a scientist were not honest, then he or she might communicate results that are false. Other scientists working on the same or similar research would be led down the wrong paths.
28. If an experiment had two manipulated variables, there would be no way to tell which of the two variables produced the experimental results.
29. If an accident occurs, notify your teacher immediately. Then listen to your teacher's directions and carry them out quickly.
30. Add 60 minutes to the *x*-axis. Draw a line of best fit through the three data points and extend that line to cross the 60-minute coordinate to find the estimated distance. Then, find the slope of the line, which represents the speed of the airplane.

Chapter 1 Test B

1. a
2. c
3. a
4. c
5. b
6. c
7. b
8. c
9. b
10. b
11. data
12. theory
13. law
14. estimate
15. line graph
16. false
17. true
18. true
19. true

20. true
21. b
22. c
23. a
24. a
25. c
26. c

Chapter 2 The Nature of Matter

Chapter 2 Performance Assessment

1. Sample: At the top of my poster, I wrote a definition of matter. On the upper left, I defined physical and chemical properties. I used a picture of an icicle to show physical state, and a picture of a fire to show flammability. On the lower left, I used words to define physical and chemical changes. I used a picture of butter melting to show a physical change and a picture of wood burning to show a chemical change. On the upper right, I made a concept map to show how mixtures, substances, elements, and compounds are related. I also used a picture of lemonade to show a mixture, one of sugar to show a pure substance, one of water to show a compound, and one of a gold necklace to show an element. On the lower right of my poster, I defined and described atoms.

2. Sample: My poster teaches visitors that matter makes up everything in the universe. Matter has two kinds of properties—physical and chemical. Freezing point is a physical property and ability to combine with oxygen is a chemical property. The melting of ice to water is an example of a physical change, and the burning of wood is an example of a chemical change. A mixture is made of two or more substances. A substance is made of only one type of matter. An element is a pure substance that cannot be broken down by chemical means. A compound is a pure substance that is formed from two or more elements. The basic particles of matter are called atoms. Atoms are very small and can form chemical bonds with other atoms.

3. Sample: I wanted to include more about atoms, but I ran out of room.

Chapter 2 Test A

1. a
2. c
3. c
4. c
5. d
6. c
7. d
8. a
9. d
10. a
11. molecule
12. compound
13. temperature
14. element
15. Energy
16. physical change
17. true
18. true
19. true
20. solid
21. Both processes involve the combination of a substance with oxygen. In both processes, new substances are created. Combustion is rapid and gives off heat and light, while oxidation is slow.
22. Sun shining on tree: electromagnetic energy (sunshine) to chemical energy (wood and leaves of tree); dead branches burned in campfire: chemical energy (wood) to thermal energy (heat) and electromagnetic energy (light).
23. Both photosynthesis and electrolysis can separate water into hydrogen and oxygen. Electrolysis uses electrical energy to perform this chemical change. Photosynthesis uses electromagnetic energy.
24. Sample answer: An element is a pure substance that cannot be broken down into any other substances. A compound is a pure substance made of two or more elements chemically combined in a set ratio.
25. Sample answer: According to the law of conservation of matter, matter is not created or destroyed in any chemical or physical change. When a candle burns, the products are carbon dioxide and water. If they could be trapped and measured, they would have the same total mass as the candle wax and wick that burned away, plus the oxygen they reacted with.
26. **a.** pure substance
b. mixture
c. mixture
d. pure substance
27. A compound is represented in figure d. Two different kinds of atoms are shown chemically combined (in molecules) in a set ratio, and no other substances are shown.

28. Sample answer: Sunshine heats the interior of a car; microwaves heat a frozen dinner in a microwave oven.
29. Sample answer: Both changes convert the substances from a solid to a liquid. However, melting ice does not change the identity of the substance, water. You can freeze the water again, and it turns back to ice. When table sugar becomes caramel, it becomes a new substance. The sugar crystals cannot be recovered by freezing.
30. Sample answer: Salt water is a mixture that is a solution. The salt and water are so well blended that they appear to be one substance. Cereal with milk is a mixture that is not a solution. You can easily see and separate the pieces of cereal from the milk. Cereal with milk is a heterogeneous mixture.

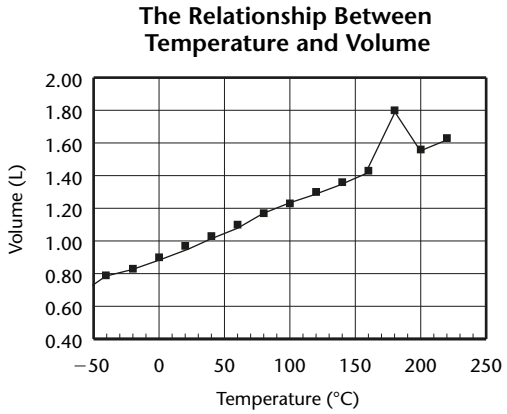
Chapter 2 Test B

1. a
2. c
3. c
4. b
5. c
6. b
7. b
8. a
9. a
10. c
11. matter
12. solution
13. chemical
14. energy
15. electromagnetic
16. true
17. false
18. false
19. true
20. true
21. c
22. b
23. a
24. c
25. c

Chapter 3 Solids, Liquids, and Gases

Chapter 3 Performance Assessment

Sample Graph:



1. A decrease in temperature results in a decrease in volume.
2. The volume at −60°C would be about 0.70 L. The volume at 240°C would be about 1.76 L.
3. The measurement of volume at 180°C seems to be incorrect because it does not fall on the straight line formed by the other data points. This measurement could be checked by heating the balloon to 180°C again and measuring its volume.
4. a change of 0.20 L

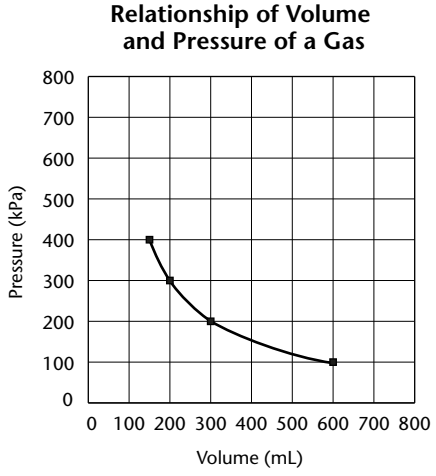
Chapter 3 Test A

1. a
2. d
3. b
4. b
5. c
6. d
7. c
8. d
9. a
10. b
11. volume
12. greater; higher
13. melting point
14. Sublimation
15. pressure
16. true
17. pressure
18. evaporation

19. melting
20. true
21.

Volume (mL)	Pressure (kPa)
600	100
300	200
200	300
150	400

22.



23. About 120 mL; answers may vary slightly based on curve of student graph.
24. Heating causes the air inside the balloon to increase in volume because the particles move faster. Some of the warm air leaves the balloon through the bottom opening, leaving the air inside the balloon less dense than the air outside the balloon, and the balloon begins to rise.
25. The particles in a solid have a fixed, closely packed arrangement and vibrate in place. The particles in a liquid are closely packed but can move around one another freely. The particles in gas move about freely and collide randomly.
26. A. gas
B. liquid
C. solid
27. 5°C; 80°C
28. The added thermal energy is making the particles vibrate faster and faster in place until they break free from their positions in the solid. The temperature stays the same because the increasing energy is being used to rearrange the particles rather than raise the temperature.
29. As the tires heat up, the temperature of the air inside them rises. This causes the air pressure in the tire to increase. In order to keep the tires from exploding because of too much pressure, truck drivers should let some air out of the tires.
30. Air pressure changes that take place inside the cabin of an airplane can create a difference between the air pressure in the inner ear and the surrounding air. This difference sometimes causes pain that can be relieved by swallowing to equalize the air pressure.

Chapter 3 Test B

1. a
2. b
3. c
4. b
5. b
6. c
7. a
8. b
9. a
10. c
11. gas
12. melting
13. sublimation
14. pressure
15. increases
16. true
17. false
18. true
19. false
20. false
21. b
22. c
23. a
24. b
25. a

Chapter 4 Elements and the Periodic Table

Chapter 4 Performance Assessment

1. Answers will vary. Sample for one family: To show that the alkali metals are in Group 1 of the periodic table and react with other elements by losing one electron, I used a photo of a sign at a football game that says "We're #1!"
2. Answers will vary. Sample for one element: I used a photo of a magnet attracting paper clips to show that iron is attracted to magnets.

Chapter 4 Test A

1. d
2. c
3. a
4. b
5. d
6. a
7. b
8. c
9. d
10. c
11. diatomic molecule
12. alkali metals
13. lanthanides; actinides
14. tracer
15. halogen
16. Metals
17. increasing
18. true
19. decreases
20. true
21. The properties of bart would be more similar to those of twee, because bart and twee are elements in the same group.
22. The nucleus of most atoms of meot would contain 12 protons and 12 neutrons.
23. Answers may vary. Samples: The transition metals are conductors, which means they transmit heat and electricity well. They are hard and shiny. Some, such as gold and copper, have unusual colors.
24. In the gold foil experiment, positively charged particles usually passed undisturbed through the foil, but a few particles were strongly deflected. The results led Rutherford to suggest that the positive charge of an atom was concentrated in the center, or nucleus.
25. The atomic number is the number of protons in the nucleus. The chemical symbol is usually a one- or two-letter symbol for the element. The name of the element may be in the square. The atomic mass is the average mass of all the isotopes of that element, in atomic mass units.
26. **A** is a halogen. It can't be an alkali metal since it's a gas. It isn't a transition metal since it isn't a conductor. It isn't an inert gas because it is reactive. Halogens are very reactive. **B** is a transition metal. Transition metals are moderately reactive compared to the other metals and they are conductors. Also, some have unusual colors. **C** is an inert gas. The inert gases do not usually react with other elements. **D** is an alkali metal. Alkali metals are very reactive solids that conduct electricity.
27. **C** would have the greatest atomic mass because the inert gases are located on the far right of the periodic table. Atomic number and atomic mass increase from left to right.
28. The modern model of an atom consists of a nucleus that contains protons and neutrons, surrounded by a cloudlike region of moving electrons. Protons are positively charged, electrons are negatively charged, and neutrons have no charge. The number of protons equals the number of electrons, so their charges balance, making the atom neutral.
29. Particle accelerators are used to cause atomic nuclei to move at extremely high speeds. When these high-speed nuclei collide, they sometimes combine into a single nucleus. This technique can create heavy elements made up of atoms with very large nuclei.
30. Radioactive isotopes give off detectable radiation, so they can be used as tracers in chemical reactions, in industrial processes, and in diagnosing medical conditions. The radiation itself can be used to kill cancer cells. Energy from radioactive decay can be harnessed in nuclear power plants to generate electricity.

Chapter 4 Test B

1. b
2. c
3. b
4. a
5. a
6. a
7. c
8. b
9. c
10. a
11. isotopes
12. atomic mass
13. alkali metals
14. halogens
15. radioactivity
16. true
17. false
18. true
19. false
20. true
21. a
22. c
23. b
24. b
25. a

Chapter 5 Atoms and Bonding

Chapter 5 Performance Assessment

1. The terms *polar* and *nonpolar* refer to covalent bonds. Some students may add that ionic compounds exist as crystals rather than as individual molecules.

2. Potassium iodide, sodium oxide, calcium chloride, lithium nitride; these compounds are ionic. All ionic compounds exist as solids at room temperature.

3. Inert gases don't react very easily with other atoms, so they are rarely found in compounds.

Chapter 5 Test A

1. b
2. c
3. b
4. d
5. b
6. c
7. b
8. a
9. d
10. b
11. alloy
12. eight
13. molecule
14. positive
15. six
16. true
17. inert gases
18. neutral
19. polar
20. true
21. **a.** $MgCl_2$
b. Al_2S_3
c. None; an atom of argon already has eight electrons and does not react easily.

22. Sodium, magnesium, and aluminum; metal atoms have one, two, or three valence electrons (that can be lost during chemical reactions).

23. The positive ions and valence electrons in metals can move freely, allowing metals to conduct heat and electric current, to give off light (luster), and to undergo a change in shape easily.

24. In an H_2O molecule, the atoms do not share the electrons equally. The electrons are closer to the oxygen atom than to either hydrogen atom. This creates a slight positive charge on one end of the molecule and a slight negative charge on the other end. In an H_2 molecule, both hydrogen atoms pull the electrons with the same strength. The electrons are shared equally, so the molecule is nonpolar.

25. Both ionic and covalent bonds involve electrons. Both kinds of bonds hold atoms together. In an ionic bond, the atoms have lost or gained electrons. Bonds form between oppositely charged ions. In a covalent bond, atoms share pairs of electrons.

26. A, Group 15; D, Group 1; E, Group 16; G, Group 13; J, Group 18; L, Group 17; M, Group 2; Q, Group 14

27. Element A can form three covalent bonds because it has five valence electrons and needs three more to have a total of eight.

28. The alkali metals have only one valence electron, which is easily lost. As a result, alkali metals are very reactive and will easily combine with other elements to form compounds.

29. Try dissolving the solid in water. Then test again to see if the solution or the liquid will conduct electricity. You could also try to melt the solid. If it melts easily (at temperatures that are reasonably achievable), it is possibly a molecular compound rather than an ionic compound.

30. The opposite ends of polar water molecules are attracted to each other. This means that a higher temperature is required to provide enough energy for the molecules to separate from one another. Carbon dioxide is composed of nonpolar molecules, so there is less attraction between these molecules and less energy is needed to separate molecules from one another, allowing them to become a gas.

Chapter 5 Test B

1. c
2. b
3. c
4. a
5. b
6. c
7. b
8. b
9. c
10. a
11. chemical bond

12. eight
13. positive
14. double bond
15. alloy
16. true
17. false
18. false
19. true
20. false
21. b
22. a
23. b
24. a
25. c

Chapter 6 Chemical Reactions

Chapter 6 Performance Assessment

1. Students' answers must demonstrate that they used observed results to evaluate their predictions.

2. Students can conclude that when iron combines with oxygen to form iron oxide, energy is released in the form of heat. This makes it an exothermic reaction.

3. Answers may vary, but should include two of the following: increase the concentration of the salt in the salt water solution; warm the jar while the reaction is taking place; break up the steel wool into smaller pieces; add a catalyst.

4. It is a synthesis reaction because iron combines with oxygen to form iron oxide.

Chapter 6 Test A

1. a
2. d
3. c
4. d
5. b
6. a
7. c
8. c
9. a
10. a
11. activation energy
12. inhibitor
13. exothermic
14. enzyme
15. fuel
16. true
17. oxygen
18. closed system
19. true
20. products
21. **a.** Reactants
b. Products
22. The reaction is an endothermic reaction, because the energy level of the products is higher than the energy level of the reactants. This indicates that the reaction took in energy.
23. No. Increasing the concentration of the reactants will increase the rate of reaction, but it will not change the activation energy.
24. Water stops combustion first by coating the fuel and stopping the flow of oxygen in the air. As the water evaporates, it also lowers the temperature and decreases the available heat.
25. Conservation of matter means that matter is neither created nor destroyed in a reaction. Therefore, there should be the same number of atoms of each element in the products and the reactants. There are 4 atoms of iron and 6 atoms of oxygen before and after the reaction.
26. **a.** $H_2 + I_2 \rightarrow 2\ HI$
b. $2\ Li + 2\ HCl \rightarrow H_2 + 2LiCl$
c. $2\ H_2O \rightarrow 2\ H_2 + O_2$
27. **a.** Synthesis: Two elements (simple substances) combine to form a compound (more complex substance). **b.** Replacement: Lithium replaces the hydrogen in the compound. **c.** Decomposition: A compound breaks down into two elements (simpler substances).
28. Adding baking soda to vinegar produces a chemical reaction. The production of gas bubbles and the disappearance of the vinegar smell indicate that a gas was released and a different substance formed.
29. Enzymes are biological catalysts. They lower the activation energy of chemical reactions in the body by providing a surface on which reactions can take place. Enzymes are necessary because these reactions would otherwise require temperatures that would be harmful to living things.
30. To balance an equation you can change the coefficients to change the number of atoms or molecules in the reaction. However, if you were to change the subscripts, you would change the identities of the substances in the reactions.

Chapter 6 Test B

1. b
2. a
3. c
4. b
5. c
6. c
7. a

8. a
9. c
10. b
11. exothermic
12. decomposition
13. activation
14. catalyst
15. fuel
16. true
17. true
18. false
19. true
20. false
21. b
22. c
23. c
24. b
25. a

Chapter 7 Acids, Bases, and Solutions

Chapter 7 Performance Assessment

1. Answers may vary. Most students will find that lemon juice is the best cleaner and baking soda the worst.

2. Answers may vary. Most students will find that solutions with lower pH clean the pennies better. pH is a measure of the concentration of hydrogen ions (H^+) in a solution.

3. Lemon juice and vinegar are acids because their pH levels are less than 7. The soapy water and baking soda solutions are bases because their pH levels are greater than 7. In addition to having pH levels below 7, acids react with metals and carbonates, and turn blue litmus paper red. In addition to having pH levels above 7, bases feel slippery, and turn red litmus blue.

Chapter 7 Test A

1. a
2. b
3. c
4. c
5. b
6. c
7. c
8. d
9. a
10. c
11. concentrated
12. corrosive
13. indicator
14. colloid
15. supersaturated
16. true
17. true
18. acid
19. solvent
20. increase
21. You can infer that the solution is a saturated solution of sugar in water because sugar crystals remain on the bottom. This means that as much sugar as possible has dissolved in the water.
22. Cooling the jar lowers the solubility of sugar in water. Since the solution is already saturated, more of the sugar will come out of the solution as it is cooled. The amount of solid sugar on the bottom of the jar would increase. If the jar was heated instead of cooled, the solubility of sugar would increase. More sugar would dissolve, and there would be fewer or no sugar crystals on the bottom. (Some students may add that if heating continues, some of the water would evaporate and the concentration of sugar in the solution would increase.)
23. The solute particles break away from each other and become surrounded by particles of the solvent. The solute and solvent become evenly mixed.
24. Etching uses acidic solutions to eat away metal. Spilled acid could injure skin and eyes and damage clothing, furniture, or floors. (Students may add that, to avoid damage or injury from acid, an artist would need to wear protective clothing, take precautions to avoid spills, and know what to do if spills occur.)
25. Adding antifreeze to the water lowers the freezing point and raises the boiling point of the liquid in the radiator. The antifreeze and water solution does not freeze in very cold weather as water alone would. It also protects the engine from overheating because it boils at a higher temperature than pure water would.
26. Ammonia is a base because it forms hydroxide ions in water.
27. You could test to see if the solution conducts electric current. If the solution is composed of ions in water, it will conduct electric current. Solutions of dissolved molecular solids do not conduct electric current.
28. A neutralization reaction takes place as the acidic rain and basic lake water react. A salt is formed, and the pH of the lake decreases.
29. A weak acid is one that doesn't easily form H^+ ions in water. A dilute acid is one in which a small amount of acid has been dissolved in water.

30. The dissolved particles of table sugar are individual molecules that are surrounded by the solvent particles. The molecules are neutral. The dissolved particles of an ionic solid, such as table salt, are positive or negative ions that are each surrounded by solvent particles.

Chapter 7 Test B

1. c
2. c
3. a
4. b
5. a
6. c
7. b
8. c
9. c
10. b
11. colloid
12. concentrated
13. supersaturated
14. indicator
15. salt
16. false
17. true
18. true
19. false
20. false
21. b
22. c
23. b
24. a
25. a

Chapter 8 Carbon Chemistry

Chapter 8 Performance Assessment

1. Answers will vary. Sample: I said one of my partner's models had a straight chain, and he said that it had a branched chain. I showed him that his model wasn't really branched, it was just bent.

2. Carbon can form only four bonds, and hydrogen can form only one.

3. Yes, oxygen can form two bonds, so it could bond to two carbon atoms.

4. Answers will vary, but all models should contain six carbons.

Chapter 8 Test A

1. d
2. c
3. a
4. b
5. d
6. d
7. a
8. c
9. a
10. c
11. branched chains
12. esters
13. vitamins
14. plastics
15. hydroxyl group
16. Proteins
17. saturated
18. true
19. true
20. nucleic acids
21. A structural formula
22. They are called isomers because they have the same chemical formula (C_4H_{10}) but different structures.
23. Saturated hydrocarbons—they contain no double or triple bonds; they are not substituted hydrocarbons—they contain only carbon and hydrocarbon.
24. Graphite is softer than diamond and feels slippery. The carbon atoms in graphite are bonded together tightly in flat layers, but the bonds connecting the layers are very weak, allowing the layers to slide easily past one another. Diamond is one of the hardest substances on earth. The carbon atoms in a diamond are arranged in a crystal structure in which every atom is bonded to four other atoms. This arrangement results in an extremely hard solid.
25. Most nutrients are organic compounds. The body needs nutrients because they provide the energy and raw materials that the body needs to grow, repair worn parts, and function properly.
26. Compound A: alcohol; CH_3OH
Compound B: halogen compound; CCl_4
27. No, these compounds do not have isomers because there is only one possible arrangement of the atoms in each compound.
28. Carbon has four valence electrons so that each carbon atom is able to form four bonds, making it possible to form many different molecules with other atoms. Also, it is possible to arrange the same number of atoms in many different ways.
29. A polymer is a very large molecule made up of a chain of monomers bonded together. Samples: Plastics are synthetic polymers. Wool is a natural polymer.

30. Synthetic polymers are better to use than natural polymers because they are inexpensive to make, strong, and last a long time. On the other hand, because synthetic polymers are not costly, people often throw them away rather than re-using them. Also, synthetic polymers do not degrade (break down) as quickly as natural polymers do. For these reasons, synthetic polymers often increase the volume of trash more than do natural polymers.

Chapter 8 Test B

1. b
2. a
3. b
4. a
5. c
6. c
7. b
8. c
9. a
10. c
11. nanotube
12. isomers
13. composite
14. glucose
15. minerals
16. false
17. true
18. true
19. false
20. true
21. b
22. b
23. a
24. a
25. c

Chapter 9 Motion and Energy

Chapter 9 Performance Assessment

1. Answers will vary depending on the toy used. Sample: The slope of the graph started out steep and then slowly decreased to zero. In other words, the toy's speed was greatest at the beginning and then slowly decreased until the toy stopped.

2. Answers may vary depending on the toy's design. Sample: The slope of the graph of a toy moving uphill would not be as steep. The total distance the toy moved would be smaller. The slope of the graph of a toy moving downhill would be steeper. The total distance the toy moved would be greater.

3. Answers will vary. Students should divide the total distance by the total time.

4. Answers may vary. Samples: the edge of the table or a piece of tape on the floor on which the toy moved.

5. Yes, the toy accelerated. It started moving from a complete stop and then returned to a complete stop.

Chapter 9 Test A

1. a
2. c
3. c
4. b
5. a
6. c
7. c
8. b
9. b
10. d
11. reference point
12. speed
13. direction
14. speed
15. can
16. true
17. time
18. true
19. velocity
20. Answers may vary. Sample: Using the station as a reference point, the train would not be moving. Using a nearby moving train as a reference point, the train would appear to be moving.
21. Answers may vary. Sample: An object moving at a constant speed is accelerating if its direction of movement is changing. Possible examples include Earth orbiting the sun and a bicycle tire rotating around its axis.
22. Sample answer: Gravitational potential energy is the energy of a stationary object positioned at some height above a reference point, such as the top seat of a Ferris wheel or a roller coaster at the top of a rise. (Some students may add that gravitational potential energy can be calculated by multiplying the weight of an object by its height.) Elastic potential energy is the energy of an object that has been squeezed or stretched, such as a coiled spring compressed by a weight.
23. 100 m
24. 5 cm/yr
25. Yes. Its speed changes from 10 cm/yr for the first 2,000 years to 0 cm/yr for the last 2,000 years.

26. It stops moving and reaches maximum height.
27. Answers may vary. Sample: It hits the ground. It falls back to the person who threw it.
28. 9.8 m/s down
29. Answers may vary. Sample: If you know the velocity of the storm, you know the direction of movement, which can be used to warn people in the path of the storm.
30. According to the law of conservation of energy, energy is never destroyed. The pinwheel slows and eventually stops because the kinetic energy of its motion changes to heat as it encounters air resistance. (Some students may mention friction and the rubbing of the wheel against the post on which it is mounted.)

Chapter 9 Test B

1. a
2. a
3. c
4. b
5. c
6. a
7. b
8. a
9. b
10. a
11. reference point
12. average
13. slope
14. instantaneous
15. acceleration
16. true
17. true
18. false
19. false
20. false
21. b
22. a
23. a
24. b
25. c

Chapter 10 Forces

Chapter 10 Performance Assessment

1. Answers may vary depending on the method used. Sample: The force of gravity pulls down on the banana. The string pulls up on the banana. The net force is zero because the banana is not accelerating.
2. The net force would be equal to the weight of the banana.
3. The banana's mass is the amount of matter it contains. Its weight is a measure of the force of gravity on the banana.
4. Answers may vary. Sample: Yes, this method could also be used on the moon. However, the acceleration due to gravity on the moon is less than that on Earth. You would need to look up the acceleration due to gravity on the moon in a reference book or on the Internet.
5. Answers may vary. Sample: You would have to determine the mass of the banana on Earth. Then use the spring scale to measure the banana's weight on Mars. Divide the weight of the banana on Mars by its mass to determine the acceleration of gravity on Mars.

Chapter 10 Test A

1. b
2. b
3. a
4. d
5. a
6. d
7. c
8. a
9. d
10. c
11. gravity
12. force
13. fluid
14. velocity
15. force
16. the same object
17. true
18. true
19. gravity
20. true
21. Answers may vary. Sample: The rocket burns fuel and produces gases. The rocket exerts an action force on the gases, pushing the gases downward. At the same time, the gases apply an equal reaction force on the rocket, pushing it upward. The force provided to the rocket by the gases exceeds the force of gravity, causing the rocket's acceleration upward.
22. The rocket is in orbit. If there was no gravity, the rocket's inertia would cause the rocket to move in a straight line. But the centripetal force of Earth's gravity causes the rocket to fall toward the center of the Earth. When gravity and the rocket's inertia are balanced, the rocket falls toward Earth at the same rate as Earth's surface curves away, leaving the rocket in orbit around Earth.

23. When a person is sliding down a water slide, gravity pulls the person down. Fluid friction occurs between water and the person. If the slide were dry, sliding friction would exist between the person and the slide. Sliding friction is greater than fluid friction. The friction on a dry slide might be so great that the person would not move down the slide.

24. The ball thrown on the moon will travel a greater distance. Air resistance will slow down a ball thrown on Earth, but not the ball on the moon. In addition, the force of gravity will be greater for the ball on Earth. The action of these forces (air resistance and gravity) decreases the distance that a thrown ball will travel before it hits the ground.

25. The balloon will move in a direction away from the open end. When the balloon is released, it exerts a force on the air inside, pushing it out of the open end and returning the balloon to its original shape. At the same time, this air exerts an equal force on the balloon, pushing it in a direction away from the open end.

26. 2 kg·m/s

27. The total momentum after the collision is 2 kg·m/s. The new momentum for Ball A is 2 kg $\times$ 0.5 m/s, or 1 kg·m/s. That means the new momentum for Ball B must be 1 kg·m/s. Dividing that momentum by 1 kg gives a velocity of 1 m/s.

28. The greatest obstacles to moving a huge block are friction and gravity. Students should suggest ways to reduce friction, such as putting the block on rollers (logs, for example), floating the block down a river, or greasing the surface in front of the block. More force is needed to start the block from a stop, due to inertia.

29. As they orbit Earth, they fall toward Earth at the same rate as Earth's surface curves away from them. They appear to stay over the same place on the equator because the equator is rotating at the same rate as they are.

30. Answers may vary. Sample: Gravity pulls the parachuting person down. Air resistance acts in the opposite direction as gravity and depends on the surface area of the falling object. The surface area of an open parachute is greater than the surface area of a person. The increased force of air resistance on the parachute works against the force of gravity to slow the person down.

Chapter 10 Test B

1. c
2. c
3. b
4. c
5. c
6. a
7. c
8. a
9. b
10. b
11. force
12. static
13. free fall
14. mass
15. velocity
16. true
17. false
18. false
19. true
20. true
21. b
22. a
23. b
24. b
25. b

Chapter 11 Forces in Fluids

Chapter 11 Performance Assessment

1. Answers will vary depending on the balls and the hair dryer speed settings. In most students' experiments, the balloon will fly up and float away, the Ping-Pong ball will be suspended in the dryer's airflow, and the golf ball will not be suspended at all. The fourth ball might be suspended. High dryer speeds will suspend heavier balls. A low speed might suspend a balloon.

2. Students should explain Bernoulli's principle—fluids in motion are lower in pressure than nearby fluids. Air is a fluid. The higher air pressure outside the column of air pushes the suspended ball into the column before it can fall to the ground. When the ball is suspended, the flow of upward air balances the downward pull of gravity. The push on the suspended ball from higher-pressure air outside the moving air does "balance" the ball in midair, but the areas of lower- and higher-pressure air should not be considered balanced.

3. Pascal's principle says that when pressure is increased on a confined fluid, the pressure is

transmitted evenly throughout the fluid. Pascal's principle does not apply in this experiment because the fluid is not confined.

4. From highest to lowest densities, the objects are golf ball, plastic or rubber ball, Ping-Pong ball, and balloon. The golf ball and possibly the rubber ball are denser than water and will sink. The rubber ball might be less dense than water and float on the surface. The Ping-Pong ball and balloon are less dense than water and will float on the surface.

Chapter 11 Test A

1. c
2. d
3. a
4. a
5. b
6. a
7. c
8. c
9. a
10. b
11. Bernoulli's
12. hydraulic
13. mass
14. increases
15. air pressure or atmospheric pressure
16. shape
17. true
18. true
19. weight
20. mass
21. 2 Pa, 2 Pa
22. 80 N
23. As the airplane's speed increases, the air moving past the wing increases speed. Air on the top curved surface of the wing moves faster than air on the flat bottom surface, so the air pressure becomes lower on the top surface. The greater pressure on the bottom pushes the wing up. This is explained by Bernoulli's principle.
24. For a helium balloon to rise, its average density must be less than air. To float at a constant level, it must have the same density as air. To sink, it must be more dense than air.
25. Since ice floats on the surface, the buoyant force acting on it must be greater than the force of gravity pulling it down. Ice must be less dense than water.
26. Since the total weight of each boat and its load is the same, each will displace the same amount of water, according to Archimedes' principle. The thinnest boat, boat c, will extend deepest into the water, so it would hit bottom first.
27. The boat would float higher on the surface of the water because its density would be less.
28. A hydraulic system is based on Pascal's principle, which says that pressure is equal throughout a confined fluid. When pressure is increased by the action of a piston in one part of the system, pressure increases by the same amount throughout the system. The relationship between pressure, force, and area is: Pressure = Force ÷ Area.
Since the fluid pressure is equal on both pistons, the force divided by the area is equal on both pistons. For the equation to hold, when force on the first piston goes up, force on the second piston goes up more, because its area is larger.
29. First, fill the bathtub to the top with water. Then take a deep breath so you will float on the surface, and get into the bathtub. Next, collect the water displaced over the side. Since you are floating at the surface, your weight is at least equal to the buoyant force holding you up. By Archimedes' principle, the buoyant force of the water displaced is equal to the weight of the water displaced. Thus, your weight (and mass) is equal to the weight (and mass) of the water displaced. Water has a density of 1 g per cm^3. Since Density = Mass $\times$ Volume, your mass in grams is equal to the volume of water displaced in cubic centimeters, which you can measure.
30. The air in the front of the moving car would be at higher pressure than air away from the car. When that area of higher pressure hits the parked car, there would be a force exerted on my car from the direction the moving car is moving. As the moving car passes, there would be moving air between the two cars. The moving air would be lower in pressure than air on the far side of the parked car, so there would be a force exerted on the parked car in the direction of the moving car.

Chapter 11 Test B

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

10. b
11. force
12. air pressure
13. mass
14. hydraulic device
15. Bernoulli's principle
16. true
17. true
18. false
19. true
20. false
21. b
22. a
23. a
24. b
25. b

Chapter 12 Earth, Moon, and Sun

Chapter 12 Performance Assessment

1. Students should show two positions of Earth, the sun, and the moon in a line, with the sun farthest from Earth and the moon. In one position, Earth is between the sun and the moon. In the other position, the moon is between Earth and the sun. In both positions, a high tide is on the side of Earth facing the moon, and on the side facing away from the moon.

2. When the moon is on the opposite side of Earth from the sun, it is full. When the moon is on the side toward the sun, it is new.

3. If connected by a line, the positions of Earth, the sun, and the moon should form a right triangle, with the sun at the vertex of the two longest sides. The moon will be at either side of Earth in the two positions. In both positions, a high tide is on the side of Earth facing the moon and on the side facing away from the moon.

4. In both positions, the moon will be half illuminated by the sun. The two positions are called first quarter and third quarter.

Chapter 12 Test A

1. c
2. d
3. b
4. b
5. c
6. a
7. d
8. c
9. b
10. c
11. solstices
12. neap tide
13. weight
14. full
15. equinox
16. rotations
17. vernal equinox
18. lunar eclipse
19. true
20. true
21. **A.** overhead
B. on the horizon
C. on the horizon
D. not visible
22. **E.** third quarter
F. new moon
G. first quarter
H. full moon
23. At most points by the seashore there are two high tides separated by two low tides during 25 hours. The length of time between a high and low tide is a little more than 6 hours.
24. The seasons are caused by the tilt of Earth's axis in relation to the plane of the orbit and the revolution of Earth around the sun. When the Northern Hemisphere is pointed toward the sun, it is warm because the sun hits the Northern Hemisphere most directly. We call that summer. Six months later, sunlight hits the Northern Hemisphere less directly, and so is more spread out and provides less heat. This is winter. During spring and fall, sunlight hits at an angle between the maximum and minimum.
25. About 4.5 billion years ago, a planet-sized object collided with Earth. Material from Earth's outer layers was ejected into orbit around Earth, where it formed a ring. Gravity caused this material to combine to form the moon.
26. Neap tides—positions B and D because the gravity of the moon and sun are pulling at right angles. Spring tides—positions C and E, because the gravity of the sun and moon are pulling along the same line.
27. During spring tides, the moon would be either new or full. A person standing at position A would observe a low tide.
28. The back side of the moon is not visible from Earth because it always faces away. Astronomers would need to send space probes to see the back side of the moon, or astronauts could go there.
29. Each month, as the moon revolves around Earth, it crosses between Earth and the sun. Occasionally, it crosses directly between Earth and the sun. Then the moon's shadow hits

Earth's surface. Anyone in this shadow sees a solar eclipse. Occasionally, the moon passes directly behind Earth, so that the moon enters Earth's shadow. People on Earth then observe a lunar eclipse. Lunar eclipses are more common than solar eclipses because Earth is larger than the moon and makes a wider shadow.

30. Gravity pulls Earth toward the sun while Earth's inertia keeps it moving forward. Gravity and inertia combine to keep Earth in orbit around the sun.

Chapter 12 Test B

1. c
2. b
3. c
4. a
5. b
6. b
7. c
8. a
9. c
10. b
11. solstice
12. weight
13. neap tide
14. full moon
15. crater
16. false
17. true
18. false
19. true
20. true
21. c
22. a
23. c
24. b
25. a

Chapter 13 Exploring Space

Chapter 13 Performance Assessment

Answers will vary. Possible answer: Landing site 1 is on Amazon Planitia. I chose this site because it is relatively level and would be a safer landing area. A nearby surface feature I would explore is Olympus Mons because it is the biggest volcano in the solar system.

Chapter 13 Test A

1. d
2. d
3. a
4. c
5. b
6. a
7. c
8. c
9. b
10. d
11. space spinoffs
12. velocity
13. Neil Armstrong
14. rovers
15. vacuum
16. John Glenn
17. true
18. true
19. Escape velocity
20. action
21. **a.** inertia **b.** gravity
22. The dotted line should go from the space craft straight upward.
23. Possible answer: The Apollo astronauts explored large areas of the moon with lunar rovers. They crashed equipment onto the moon's surface to measure the moonquakes that resulted. This helped determine that the moon probably has a small area of molten rock at its center. The astronauts collected rock and soil samples to take back to Earth. Scientists who studied the samples learned that the moon is made up of a variety of rock types. Scientists also estimated the ages of the rocks and when different parts of the moon's surface formed.
24. Both solid-fuel and liquid-fuel rockets contain a source of oxygen that allows the fuel to burn. Solid fuel is a dry explosive chemical. Liquid fuel is in liquid form. Ion rockets expel gas ions at very high speeds to create thrust. They do not burn chemical fuel.
25. All space probes contain a power system, a communication system, and scientific instruments. However, space probes carry different scientific instruments, depending on the specific probe's mission.
26. In Figure B, it is 6:00 P.M. Eastern Standard Time. A geostationary satellite travels at the same speed that Earth rotates and stays over the same place on Earth all the time. The satellite has moved halfway around Earth, which means that Earth is halfway through its 24-hour cycle of rotation, or 12 hours later than in Figure A.
27. The satellite will be at position A.
28. In the 1950s, the Soviet Union and the United States were military and political rivals. In 1957, the Soviets launched the satellite *Sputnik I* into orbit. This began a competition

between the two countries. The United States responded by accelerating its own space program and establishing NASA.

29. Possible answer: Athletic shoes have a shock-absorbing material that was originally developed for astronauts' moon boots. Tennis rackets and golf clubs are made of lightweight materials used in spacecraft to make them lighter. Joysticks were originally used in airplanes. They were later used by astronauts to steer lunar rovers and are now used by people on Earth to play video games.

30. Space shuttles transport people and objects into orbit. Shuttles have a crew cabin in which astronauts can breathe without an oxygen tank and wear regular clothes. Shuttles also have a payload bay that holds supplies, such as satellites or laboratories, to be transported.

Chapter 13 Test B

1. b
2. b
3. a
4. a
5. b
6. c
7. b
8. b
9. a
10. b
11. velocity
12. satellite
13. rovers
14. vacuum
15. space spinoffs
16. true
17. false
18. false
19. true
20. true
21. b
22. a
23. a
24. c
25. b

Chapter 14 The Solar System

Chapter 14 Performance Assessment

1. Answers will vary. Possible answers:
The sun. Contains over 99 percent of all of the mass of our solar system. The sun's energy comes from nuclear fusion. The sun has an atmosphere with three parts. From inside to outside, these are the photosphere, which is where the sun's light comes from; the chromosphere; and the corona. The chromosphere and corona are normally visible only during eclipses. Features on the sun include these: Sunspots are dark, cooler areas on the sun; prominences are loops connecting parts of sunspot regions; solar flares are huge explosive loops of gas.
Mercury. The smallest of the inner planets and closest to the sun. No moons. Rotates on its axis once each 59 days. Has almost no atmosphere, very hot on the side facing the sun but very cold on the other side.
Jupiter. One of the gas giants. Largest planet. Its day is less than 12 hours long. Its Great Red Spot is a long-lasting storm in its atmosphere. Dozens of known moons, four of which were discovered by Galileo. One of its moons, Europa, may have liquid water beneath an icy crust.
Comets. Most comets have long, elliptical orbits that take them close to the sun and back out far beyond Earth's orbit. When heated by the sun, comets have three parts: the nucleus, or solid inner core; a coma, formed when sunlight turns the ice into a cloud of gas and dust; and a tail that can be more than 100 million kilometers long. Most comets have two tails—a gas tail and a dust tail. The tails usually point away from the sun, even when the comet itself is moving away from the sun.

2. Answers may vary. Possible answers: The relative size of the planets is difficult to show so that wasn't included. For example, I wanted to draw each of my objects so that anyone using my cards could compare the sizes, but even if I drew the sun as large as possible on its card, a tiny dot would have been too big to represent an asteroid or Mercury. The relative distances of the objects from the sun are also difficult to show.

Chapter 14 Test A

1. a
2. d
3. b
4. d
5. d
6. c
7. b
8. d
9. a
10. b
11. ellipses/elliptical
12. moon

13. astronomical units
14. Sunspots
15. liquid water/an ocean
16. convection
17. heliocentric
18. true
19. true
20. fusion
21. Planet C will take the longest amount of time to revolve around the star because it is the greatest distance from the star.
22. The ancient Greeks developed and generally supported the geocentric model. Most of them would have described Planets A and C as revolving around Earth, Planet B.
23. They noticed that patterns of stars kept the same shapes from night to night and from year to year. However, several objects wandered slowly among the stars. The ancient Greeks called these objects planets.
24. Nuclear fusion occurs at the extremely high temperatures and pressure in the sun's core. Hydrogen atoms join to form helium atoms. The helium atoms have a smaller mass than the total mass of the hydrogen from which they are formed. The lost mass is changed into energy.
25. Jupiter, Saturn, Uranus, and Neptune, the gas giants, are all relatively large in size and mass, and they are composed mainly of hydrogen and helium, much of it in liquid form. They do not have solid surfaces and are surrounded by rings. They also have many moons. The inner planets are much smaller and denser, and they have solid, rocky surfaces.
26. The farther the distance from Jupiter, the more time it takes a moon to revolve around the planet.
27. About 9.4 times (16.69 ÷ 1.77)
28. The side of Mercury that faces the sun is extremely hot because the planet is so close to the sun. Since Mercury has almost no atmosphere, at night most of the heat escapes into space.
29. Images of Mars from space reveal surface patterns that look as if they were made by ancient streams, lakes, or floods. Close inspection of surface features and rocks by *Spirit* and *Opportunity* rovers provided additional evidence that liquid water once existed on Mars's surface. The presence of liquid water means that life may have once existed there.
30. Venus is closer to the sun than Earth, so it receives more solar energy than Earth. Some of this energy reaches Venus's surface and is later given off as heat. The carbon dioxide in Venus's thick atmosphere traps much of this heat. The result is that Venus has the hottest surface of any planet in the solar system.

Chapter 14 Test B

1. a
2. b
3. c
4. c
5. c
6. b
7. c
8. c
9. b
10. a
11. ellipse
12. sunspots
13. terrestrial
14. ring
15. meteorite
16. true
17. false
18. true
19. false
20. true
21. a
22. c
23. c
24. b
25. c

Chapter 15 Stars, Galaxies, and the Universe

Chapter 15 Performance Assessment

1. The small object in the model must represent the object from the second column of the table.
2. The large object in the model must represent the object from the first column of the table.
3. Answers may vary. Possible answer: There are large differences in size between the categories of objects discussed.
4. Answers may vary but should include that the third object would have to be 100 times smaller or larger.
5. The ratio of the largest to smallest object would be about 10,000,000 to 1. If an object 1 mm in diameter were chosen as the smallest, the largest would be about 10 kilometers in diameter.

6. Students' diagrams should be similar to "The Lives of Stars" diagram in the textbook. A star's mass determines its life history.

Chapter 15 Test A

1. b
2. b
3. d
4. a
5. a
6. b
7. c
8. b
9. b
10. a
11. eclipsing binary
12. radio telescope
13. refracting
14. reflecting
15. nebula
16. true
17. galaxy
18. true
19. apparent brightness
20. red (or reddish)
21. parallax
22. view 2
23. It is closer to Earth than star B.
24. A spectrograph breaks the light from an object into colors and makes an image of the resulting spectrum. Spectrums from different stars vary, depending on the temperature of the stars. Astronomers examine the spectrums of stars to determine what elements are in the stars and how much of each element there is.
25. A star's absolute brightness is how bright it would appear if it were at a standard distance from Earth. A star's apparent brightness is how bright it actually appears from Earth. Stars with much greater absolute brightness than the sun have apparent brightness much less than the sun because they are much farther away from Earth than the sun.
26. Hertzsprung-Russell diagram, or H-R diagram
27. region B; main sequence
28. Region D contains the brightest stars. These stars would be giants and supergiants.
29. About 5 billion years ago, a cloud of gas and dust called the solar nebula started collapsing. Gradually, it formed a spinning disk. When gravity pulled enough gas into the center, it became hot and dense enough for nuclear fusion to begin. The sun was born. Elsewhere in the disk, small, asteroid-like bodies called planetesimals formed. The spheres closest to the sun lost most of their gases and became the inner planets. The spheres farthest from the sun became the gas giants. Most comets formed near Jupiter and Saturn and were later flung out to the outer solar system. Beyond the gas giants, a huge disk of ice and other substances formed. Pluto also formed in this region.
30. Spiral galaxies have long arms that spiral out from the center. Earth is in a barred spiral galaxy called the Milky Way. The spiral arms have many bright, young stars and large amounts of gas and dust. Elliptical galaxies look like balls or eggs. They lack gas and dust, so new stars are no longer forming in them. Irregular galaxies have irregular shapes, many bright, young stars, and lots of gas and dust to form new stars.

Chapter 15 Test B

1. c
2. a
3. b
4. b
5. c
6. a
7. b
8. a
9. c
10. b
11. refracting
12. spectrograph
13. black hole
14. elliptical
15. big bang
16. true
17. false
18. false
19. true
20. true
21. a
22. a
23. b
24. c
25. a