

# 1 Review

## Understand Key Concepts

1. In the diagram of the process of scientific inquiry, which skill is missing from the Test Hypothesis box?
- A. Analyze results.      C. Make a model.  
B. Communicate results.      D. Make observations.

### Test Hypothesis

- Design an Experiment
- Gather and Evaluate Evidence
- Collect Data/Record Observations

2. You have the following data set: 2, 3, 4, 4, 5, 7, and 8. Is 6 the mean, the median, the mode, or the range of the data set?
- A. mean      C. mode  
B. median      D. range
3. Which best describes an independent variable?
- A. It is a factor that is not in every test.  
B. It is a factor the investigator changes.  
C. It is a factor you measure during a test.  
D. It is a factor that stays the same in every test.

## Critical Thinking

4. Predict what would happen if every scientist tried to use all the skills of scientific inquiry in the same order in every investigation.
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5. Assess the role of measurement uncertainty in scientific investigations.
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6. Evaluate the importance of having a control group in a scientific investigation.



## The BIG Idea

7. What process do scientists use to perform scientific investigations? List and explain three of the skills involved.
8. Infer the purpose of the pink dye in the scientific investigation shown in the photo.

## Understand Key Concepts

- 1 C. Make a model.
- 2 D. range
- 3 B. It is a factor the investigator changes

## Critical Thinking

- 4 Sample Answer: Scientific progress would slow down because scientific testing would contain unnecessary steps.
- 5 Sample Answer: Because measurement uncertainty is unavoidable, it must be correctly communicated to others and managed.
- 6 The control group reveals whether the experimental observations are a result of changing a variable or not.

## Review

- 7 scientific inquiry; devising a testable hypothesis-If the hypothesis is not testable, it is of little value. devising an experiment to test the hypothesis-If the experiment is not well thought out, the results might have little value. drawing reasonable conclusions-If the conclusions do not make reasonable inferences from the data, they have no value.
- 8 The pink dye is an indicator that gives scientists a reference point to measure. The movement of the pink dye shows the movement of the ice.





## 2.1 Tools of Technology

- Science and technology are connected through information. New scientific information can lead to new technology products or processes.
- In order to improve or create **technology**, **resources** such as people and materials are needed.



technology  
resource  
skill  
tool  
machine  
capital  
energy

## 2.2 Materials and Their Properties

- Materials are selected for use by their **chemical properties**, **physical properties**, and **mechanical properties**.
- Materials are modified so they have the needed properties for different technologies. **Alloys** are blends of metals used in the automotive industry.
- Materials are classified by how they originated. Wood comes from living things. Materials, such as ceramics, come from mineral deposits.



physical property  
chemical property  
mechanical property  
polymers  
composite material  
alloy

## 2.3 The Design Process

- The **design process** is a series of steps used to find a solution to a specific problem.
- Solutions can be tested and compared using methods, such as the **Pugh Chart**. These methods can be used to compare solutions based on **criteria** and **constraints**.



design process  
problem statement  
criteria  
constraints  
brainstorming  
Pugh Chart  
prototype

## 2.4 Technology Systems

- A **subsystem** is a smaller **system** within a larger system. A traffic signal is a subsystem of the transportation system.
- Adding a **feedback** to an **open-loop system** converts it to a **closed-loop system**. Feedback monitors an output of a system and keeps the system running smoothly.
- Manual control** is a device operated and controlled by a human. **Automatic control** is a device that can be programmed to operate without human intervention.
- Life cycle analysis** is a method to determine the environmental impact of a product from the manufacturing stage through to the disposal stage.



system  
subsystem  
open-loop system  
input  
process  
output  
feedback  
closed-loop system.  
life cycle analysis

# 2 Review

## Understand Key Concepts

- Which technology resource is the source of power that runs technological systems?
  - people
  - tools
  - energy
  - capital
- Which term provides information on how a product can reduce its environmental impact?
  - open-loop system
  - closed-loop system
  - life cycle analysis
  - Pugh Chart

Use the Design Process flowchart to answer questions 3 and 4.



- In which step of the design process would a Pugh Chart be used?
  - Step 1
  - Step 3
  - Step 4
  - Step 5
- What is the typical next step after building a prototype?
  - brainstorming
  - manufacturing
  - selling
  - testing
- Multiplication is a subsystem of
  - division.
  - mathematics.
  - subtraction.
  - geography.
- What is the normal flow of an open-loop system?
  - input, process, output
  - process, input, output
  - input, feedback, process, output
  - input, output, process, feedback

- What type of material resource does the image below represent?



- manufactured materials
  - processed materials
  - raw materials
  - synthetic materials
- Which mechanical property determines a material's ability to resist bending?
    - elasticity
    - flexibility
    - hardness
    - strength
  - What part of a product's life cycle analysis is finding another use for the product?
    - materials processing
    - manufacturing the product
    - using the product
    - recycling of the product
  - In a large city, there are many ways to get around. There are buses, trains, and taxicabs. All of these are parts of the overall transportation system of the city. What do we call these smaller parts of the larger transportation system?
    - system
    - subsystem
    - open-loop system
    - closed-loop system
  - Which type of material does a doctor use to replace or repair broken bones?
    - alloys
    - ceramics
    - composites
    - polymers



- alloys
- ceramics
- composites
- polymers

12. What is one method to test and compare different solutions?
- A. brainstorming
  - B. design process
  - C. Pugh Chart
  - D. problem statement

## Critical Thinking

13. Explain why technologists must consider cost when they plan to manufacture a product.

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14. Compare manual controls to automatic controls.

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15. Discuss how materials are selected for a particular product.

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16. Explain Why do people diagram plans?

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17. Determine If you test and adjust your solution, are you using an open-loop or closed-loop system?

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18. Give Example Name one form of technology that you frequently use. Describe how your life would be different if that technology never had been developed.

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19. Decide Would you rather work as a scientist or as an engineer as a career? What personal strengths or weaknesses led you to your decision?

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20. Conceive Brainstorm a new invention that would make your classroom a better place for students. List the materials that you would use to build your device. How did you select the materials for your device?

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## Writing in Science

21. Create a flowchart to show the design process used to develop a skateboard.



## The BIG Idea

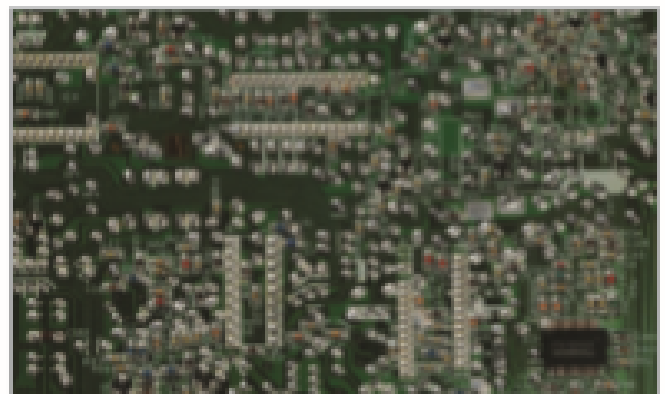
22. Describe how tools and materials are used to modify or create new technologies.

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23. How do scientists and engineers select materials for a new product?

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## Understand Key Concepts

- 1 C. energy
- 2 C. life cycle analysis
- 3 C. Step 4.
- 4 D. testing
- 5 B. mathematics
- 6 A. input, process, output
- 7 A. manufactured materials
- 8 B. flexibility
- 9 D. recycling of the product
- 10 B. subsystem
- 11 A. alloys
- 12 C. Pugh Chart

## Critical Thinking

- 13 They must ensure the cost to make a product is less than what it will sell for.
- 14 A manual control is a device that requires a user to operate. An automatic control is a device that can be programmed to operate without human intervention.
- 15 Materials are selected based on their physical, chemical, and mechanical properties.
- 16 It helps people organize what they plan to do. The diagram helps them see relationships that exist within their plan.
- 17 You are using a closed-loop system because you are using feedback to determine the need to adjust.
- 18 Answers will vary. A possible response could include comments about how the student could or could not compensate for the lack of the particular technology in his or her life.
- 19 Answers will vary. Responses could include comments about whether the particular student feels more comfortable working with ideas, or prefers to work hands-on solving problems.
- 20 Answers will vary. Responses should include comments about the advantages of various materials based on the materials' properties.





### 3.1 Types of Energy

- **Energy** is the ability to cause change.
- **Kinetic energy** is the energy of objects in motion, including **electric energy**. The forms of **potential energy** include gravitational potential energy, **chemical energy**, and **nuclear energy**. **Thermal energy** and **mechanical energy** are forms of energy involving both kinetic and potential energies. Sound energy, **seismic energy**, and **radiant energy** are all transferred by waves.
- Energy is used to move cars, heat homes, produce light, move muscles, catch prey, and cook food among many other examples.



energy  
kinetic energy  
electric energy  
potential energy  
chemical energy  
nuclear energy  
mechanical energy  
thermal energy  
sound energy  
seismic energy  
radiant energy

### 3.2 Energy Transformations and Work

- The **law of conservation of energy** states that energy can be transformed from one form to another, but it can never be created or destroyed.
- Energy can be transformed from one form to another in a variety of ways.
- Doing **work** on an object transfers energy to the object.



energy  
transformation  
law of conservation  
of energy  
work

### 3.3 Machines

- **Simple machines** do work using one movement.
- Machines make work easier by changing the size of the force required, the distance over which the object moves, or the direction of the input and output forces.



simple machine  
inclined plane  
screw  
wedge  
lever  
wheel and axle  
pulley  
complex machine  
efficiency

# 3 Review

## Understand Key Concepts

- Which of the following is gravitational potential energy?
  - the energy stored in an object that is 10 m above the ground
  - the energy of an electron moving through a copper wire
  - the energy stored in the bonds of a carbohydrate molecule
  - the energy stored in the nucleus of a uranium atom

- Which of the following increases the kinetic energy of an object?
  - decreasing the mass of the object
  - decreasing the volume of the object
  - increasing the object's height
  - increasing the object's speed

- At which point in the photo below is the gravitational potential energy the greatest?

- I
- II
- III
- IV



- The input work Shelly does on a rake is 80 J. The output work the rake does on the leaves is 70 J. What is the efficiency of the rake?

- 70 percent
- 80 percent
- 87.5 percent
- 95.4 percent

- Which of the following types of electric energy plants transforms gravitational potential energy to electric energy?

- fossil fuel
- geothermal
- hydroelectric
- nuclear

- What energy transformation occurs in a clothes iron?

- chemical to electric
- electric to thermal
- kinetic to chemical
- thermal to electric

- How much work did the man do on the toolbox in the illustration below?



- 0.06 m/N
- 17 N/m
- 425 J
- 2,125 J

- Which form of energy is NOT carried by waves?

- chemical energy
- radiant energy
- seismic energy
- sound energy

- Which is NOT a simple machine?

- inclined plane
- lever
- loop and hook
- wheel and axle

## Critical Thinking

10. **Infer** How does an airplane's kinetic energy and potential energy change as it takes off and lands?

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11. **Critique** You overhear someone say, "I'm going to nuke it" when referring to cooking food in a microwave. Explain why this terminology is incorrect.

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12. **Consider** You are going to turn a screw using a wrench. Will the work you do on the wrench be more or less than the work done by the wrench on the screw? Explain.

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13. **Compare** Describe the energy transformations that are similar in the human body and in fossil fuel electric energy plants.

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14. **Explain** A coach sets up a tug-of-war between two evenly matched teams. Both teams pull against the rope as hard as they can, but the rope does not move. Is any work being done? Why or why not?

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15. **Consider** You pull a nail out of a piece of wood using the back of a hammer. When you feel the nail, it is warm. Why?

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16. **Explain** at least two reasons why the spatula pictured below is considered a simple machine.



## Writing in Science

17. **Write** Find a complex machine around your house or your school, and write a paragraph describing the different simple machines that it contains.



## The BIG Idea

18. How is energy transformed in electric energy plants, in roller coasters, and by machines?
19. The photo below shows the deck of a sailboat. How do the pulleys make raising the sails easier?

## Math Skills

### Calculate Work

20. Humpty Dumpty weighs 400 N. He falls off a wall 3 m high. How much work was done by gravity on Humpty Dumpty?
21. A mover lifts a 12-kg box straight up 1.5 m. How much work is done on the box?

## Understand Key Concepts

- 1 A.** the energy stored in an object that is 10 m above the ground
- 2 D.** increasing the object's speed
- 3 B.** II.
- 4 C.** 87.5 percent
- 5 C.** hydroelectric
- 6 B.** electric to thermal
- 7 C.** 425 J
- 8 A.** chemical energy
- 9 C.** loop and hook

## Critical Thinking

- 10** As an airplane takes off, its kinetic energy increases because it is moving faster and faster. Its gravitational potential energy also increases as it moves farther from Earth's surface. Its kinetic energy decreases as its speed decreases; its gravitational potential energy decreases as its height above Earth decreases.
- 11** When someone says they are going to "nuke" it, they infer that they are using nuclear energy to cook the food. Actually, the person is using radiant energy in the form of microwaves to cook the food.
- 12** Work you do on the wrench will be more than the work done by the wrench. Because of the law of conservation of energy, the wrench cannot do more work than you or it would be creating energy.
- 13** Both fossil fuel electric energy plants and the human body convert chemical energy stored in plants to energy that is used to perform specific tasks.
- 14** No work is being done, because there is no movement.
- 15** In every energy transfer, some energy is converted to thermal energy in the surrounding materials. There is a lot of friction between the nail and the wood, so a lot of thermal energy is transferred to the nail during the energy transfer.
- 16** The part that is moving the egg has an inclined plane surface so that it can slip under the food easier. When you flip the egg over, you use the spatula as a lever.

- 17** Answers will vary. Many good topic choices for the paragraph exist in the kitchen and bathroom. A can opener involves wedges and wheels and axles on the gears, a wedge on the blade, and a lever on the handles. Similarly a nail clipper is a wedge and a lever. A pizza cutter is a wedge.



## The **BIG** Idea

- 18** Energy is transformed from one form to another in electric energy plants. For example, in nuclear energy plants, the potential energy stored in the nucleus of an atom is transformed into electric energy in the nuclear reactor. In roller coasters, gravitational potential energy is transformed into kinetic energy as the height above Earth changes in the roller coaster and as its speed changes. Machines change the direction of the force, the distance it is applied, and the size of the force required to do work.
- 19** The pulleys allow the sailors to pull down on the ropes to lift the sails instead of climbing the poles to pull the sails into place.

### Math Skills

#### Calculate Work

**20**  $W = 400 \text{ N} \times 3 \text{ m} = 1200 \text{ J}$

**21**  $W = (9.8 \text{ m/s}^2 \times 12 \text{ kg}) \times 1.5 \text{ m} = 176.4 \text{ J}$

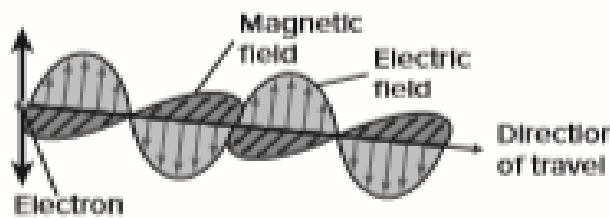


# Standardized Test Practice

## Multiple Choice

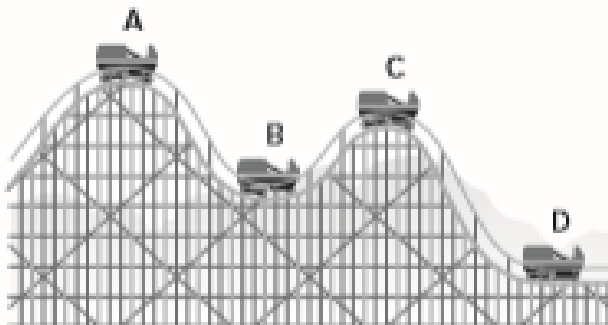
- 1 What does all energy have?
- A size and shape
  - B mass and volume
  - C the ability to cause change
  - D the ability to transport matter

Use the figure below to answer question 2.



- 2 Which form of energy is being transmitted in the picture?
- A chemical energy
  - B electric energy
  - C radiant energy
  - D sound energy
- 3 How do people use the nuclear energy produced from nuclear fission?
- A to produce electric energy
  - B to power handheld machines
  - C to grow and maintain body cells
  - D to cook food in a microwave oven
- 4 Which is true of energy?
- A It cannot be destroyed.
  - B It cannot be transmitted.
  - C It cannot change matter.
  - D It cannot be transformed.

Use the figure below to answer questions 5 and 6.



- 5 The figure shows four cars on a roller coaster track. At which point is gravitational potential energy the greatest?
- A point A
  - B point B
  - C point C
  - D point D
- 6 What happens to the roller-coaster car's energy as it moves from point A to point B?
- A New energy is created.
  - B The energy is destroyed.
  - C New energy transforms from the car's mass.
  - D The energy transforms from one kind to another.
- 7 Which equation shows how work and force are related?
- A  $\text{work} = \text{force} + \text{distance}$
  - B  $\text{work} = \text{force} - \text{distance}$
  - C  $\text{work} = \text{force} \times \text{distance}$
  - D  $\text{work} = \text{force} \div \text{distance}$

Use the figure below to answer question 8.



- 8 The figure shows a person using a hammer to remove a nail from a board. Which simple machine describes how the hammer is being used in this picture?
- A inclined plane
  - B lever
  - C pulley
  - D wedge

- 9 How can simple machines make work easier?
- A by increasing the amount of work done
  - B by decreasing the amount of work done
  - C by changing the distance or the force needed to do work
  - D by getting rid of the work needed to move an object

### Constructed Response

- 10 A softball has more mass than a baseball. Compare the kinetic energy of a softball with that of a baseball moving at the same speed.

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- 11 What is an energy transformation? Give an example of an energy transformation used to cook food.

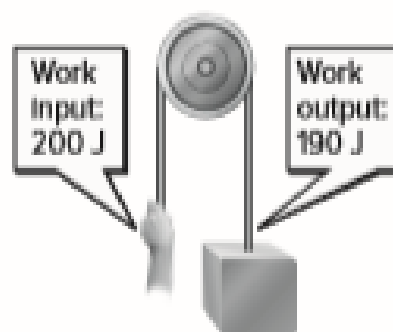
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Use the figure to answer questions 13 and 14.



- 12 What simple machine is shown? What is the efficiency of this machine?

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- 13 How could the efficiency of this machine be improved? Could it ever be 100%? Explain.

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## Multiple Choice

- 1 C—Correct.** A, B, and D are not true of all forms of energy.
- 2 C—Correct.** A is incorrect because the dark- and light-shaded fields are perpendicular to each other. B is incorrect because the electron vibration produces the light-shaded field in one plane. D is incorrect because both fields carry the energy of an electromagnetic wave.
- 3 A—Correct.** B is true of electric and chemical energy, C is true of chemical energy, and D is true of radiant energy.
- 4 A—Correct.** B, C, and D are incorrect because the opposite of each statement is true.
- 5 A—Correct.** B, C, and D are incorrect because they are all at lower heights than point A.
- 6 D—Correct.** A and B are incorrect because of the law of conservation of energy, and C is incorrect because a roller coaster car's energy is not explained by conversions between matter and energy.
- 7 C—Correct.** A, B, and D do not show that work is the product of force and distance.
- 8 B—Correct.** A and D can be true of a hammer but not as it is shown here, and C is incorrect because a hammer does not have a rope wrapped around a grooved wheel.
- 9 C—Correct.** A and B are incorrect because machines do not increase or decrease the amount of work done. D is incorrect because a machine cannot eliminate work output.

- 10** If the two balls are traveling at the same speed, the kinetic energy depends on mass. The softball would have more kinetic energy than the baseball.
- 11** Sample answer: An energy transformation occurs when energy is converted from one form to another. On a gas stove, for example, the chemical energy of gas is converted to thermal energy when the gas is burned. This thermal energy is transferred to the food. As its temperature increases, the food cooks.
- 12** The pulley's efficiency is 95 percent.
- 13** The efficiency of the pulley system could be increased by reducing friction at the center of the pulley. Also, reducing any slippage of the line that runs through the pulley would result in less wasted thermal energy produced due to friction between the line and the pulley. The efficiency of this machine can never be 100%. Friction never can be totally eliminated in any machine.

## 4.1 Substances and Mixtures

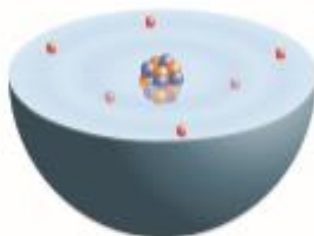
- An **atom** is a building block of **matter**. An **element** is matter made of only one type of atom. A **compound** is a **substance** that contains two or more elements.
- A **heterogeneous mixture** is not a solution because the substances that make up a heterogeneous mixture are not evenly mixed. The substances that make up a solution, or a **homogeneous mixture**, are evenly mixed.
- **Mixtures** differ from compounds in their composition, whether their parts join, and the properties of their parts.



matter  
atom  
substance  
element  
molecule  
compound  
mixture  
heterogeneous mixture  
homogeneous mixture

## 4.2 The Structure of Atoms

- The center of an atom is the **nucleus**. The nucleus contains **protons** and **neutrons**. **Electrons** occupy the space in an atom outside the nucleus.
- The identity of an atom is determined by its **atomic number**. The atomic number is the number of protons in the atom.
- The identity of an atom stays the same if the number of neutrons or electrons changes.



nucleus  
proton  
neutron  
electron  
electron cloud  
atomic number  
isotope  
ion

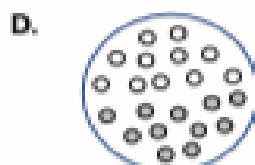
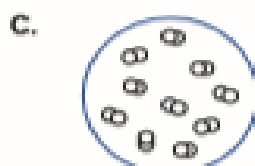
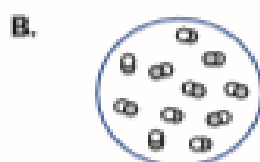
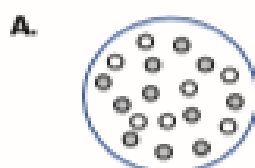
## 4 Review

## Understand Key Concepts

1. Which is a substance?

- A. fruit salad
- B. granola cereal
- C. spaghetti
- D. table salt

2. Which is the best model for a homogeneous mixture?



3. Which is a property of all atoms?

- A. more electrons than protons
- B. a nucleus with a positive charge
- C. a positively charged electron cloud
- D. same number of protons as neutrons

4. Which is another name for a solution?

- A. element
- B. compound
- C. heterogeneous mixture
- D. homogeneous mixture

5. Which would you most likely be able to separate into its parts by filtering?

- A. heterogeneous mixture of two liquids
- B. heterogeneous mixture of two solids
- C. homogeneous mixture of two liquids
- D. homogeneous mixture of two solids

6. Where is almost all the mass of an atom located?

- A. in the electrons
- B. in the neutrons
- C. in the nucleus
- D. in the protons

7. Which best describes an electron cloud?

- A. an area of charged particles with a fixed boundary
- B. electrons on a fixed path around the nucleus
- C. mostly empty space with tiny charged particles in it
- D. a solid mass of charge around the nucleus

8. Which is true about carbon-12 compared with carbon-13?

- A. Carbon-12 has more neutrons.
- B. Carbon-12 has more protons.
- C. Carbon-13 has more neutrons.
- D. Carbon-13 has more protons.

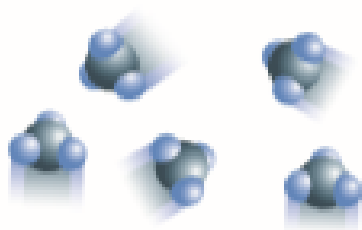
9. Look at the periodic table block below for potassium. How many electrons does an uncharged atom of potassium have?

potassium 19 <b>K</b> 39.10
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- A. 19
- B. 20
- C. 39
- D. 40

## Critical Thinking

10. **Classify** Look at the illustration below. Is this a model of a substance or a mixture? How do you know?



11. **Deduce** Each atom of protium has one proton, no neutrons, and one electron. Each atom of deuterium has one proton, two neutrons, and one electron. Are these the same or different elements? Why?
12. **Decide** Suppose you mix several liquids in a jar. After a few minutes, the liquids form layers. Is this a homogeneous mixture or a heterogeneous mixture? Why?
13. **Describe** a method for separating a mixture of salt water.
14. **Generalize** Consider the substances  $N_2O$ ,  $H_2$ ,  $CH_4$ ,  $H_2O$ ,  $KCl$ , and  $O_2$ . Is it possible to tell just from the symbols and the numbers which are elements and which are compounds? Explain.
15. **Suggest** how you can define an electron cloud differently from the chapter.
16. **Analyze** A substance has an atomic number of 80. How many protons and electrons do atoms of the substance have? What is the substance?

## Writing in Science

17. **Write** a paragraph in which you explain the modern atomic model to an adult who has never heard of it before. Include two questions he or she might ask, and write answers to the questions.



## The BIG Idea

18. Explain how compounds, elements, heterogeneous mixtures, homogeneous mixtures, matter, and substances are related.
19. The photograph below depends on its parts. This is similar to the relationship of matter and atoms. How does the classification of matter depend on atoms?

## Math Skills

### Use Scientific Notation

20. The mass of one carbon atom is 0.0000000000000000000000001994 g. Express this number in scientific notation.
21. The mass of an electron is about  $9.11 \times 10^{-31}$  kg. Write this as a whole number.
22. In 1 L of hydrogen gas, there are about 54,000,000,000,000,000,000 hydrogen atoms. Express the number of atoms using scientific notation.
23. Particles in chemistry are often described by the unit mole. One mole is defined as about  $6.022 \times 10^{23}$  particles. Write this as a whole number.
24. The mass of hydrogen-3, tritium, is about  $5.01 \times 10^{-27}$  kg. Write this as a whole number.

## Understand Key Concepts

- 1 D. table salt
- 2 A.
- 3 B. a nucleus with a positive charge
- 4 D. homogeneous mixture
- 5 B. heterogeneous mixture of two liquids
- 6 C. in the nucleus
- 7 C. mostly empty space with tiny charged particles in it
- 8 C. Carbon-13 has more neutrons.
- 9 A. 19

## Critical Thinking

- 10 The drawing is a model of a substance, specifically, a compound. You can tell because the combination of atoms is always the same.
- 11 They are the same element (hydrogen) because they have the same number of protons. Protium and deuterium are isotopes of hydrogen—the number of neutrons they have varies.
- 12 It is a heterogeneous mixture because it contains substances that are not evenly mixed.
- 13 You could heat the water until it boils. The water would evaporate, leaving behind the salt.
- 14 Yes; an element has just one type of atom, although the molecule may contain more than one atom of that element. A compound has more than one type of atom.  $H_2$  and  $O_2$  are the only elements listed because they have only one type of atom.
- 15 Sample answer: An electron cloud is the area of negative charge around a nucleus.
- 16 Atoms of the substance have 80 protons and 80 electrons. The substance is mercury.

- 17** Paragraphs should describe a positively charged nucleus surrounded by an electron cloud. Protons and neutrons are in the nucleus, and electrons are in the electron cloud. Sample questions and answers: Where are the electrons located? *The electrons are located in the empty space around the nucleus. The space is usually described as a cloud since we cannot be sure exactly where each electron is at a given moment.* Which particles have a positive charge and which particles have a negative charge? *Protons have a positive charge, electrons have a negative charge, and neutrons are neutral.*



## The **BIG** Idea

- 18** Matter is classified as either a substance or a mixture. Two types of substances are elements and compounds. Two types of mixtures are heterogeneous mixtures and homogeneous mixtures.
- 19** The classification of matter depends on the number and arrangement of atoms. Substances are elements, which are made of one type of atom, or compounds, which are made of two or more atoms that have bonded together. On the other hand, mixtures are made of two or more substances that have not chemically bonded. The composition of a mixture may vary.

### Math Skills

#### Use Scientific Notation

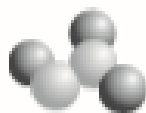
- 20**  $1.994 \times 10^{-23}$  g
- 21** 0.0000000000000000000000000000911 kg
- 22**  $5.4 \times 10^{22}$  atoms
- 23** 602,200,000,000,000,000,000,000 particles
- 24** 0.0000000000000000000000000501 kg

# Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

## Multiple Choice

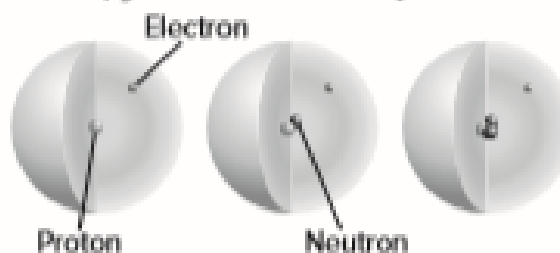
Use the figure below to answer questions 1 and 2.



- How many atoms are in the particle?
  - 1
  - 2
  - 3
  - 5
- Which kind of matter might contain only this type of particle?
  - a compound
  - an element
  - a heterogeneous mixture
  - a homogeneous mixture
- Which class of matter is the least evenly mixed?
  - compounds
  - heterogeneous mixtures
  - homogeneous mixtures
  - solutions
- Which correctly describes a compound but not a mixture?
  - All the atoms are of the same element.
  - All the molecules have at least two atoms.
  - The combination of substances never changes.
  - The substances can be separated without breaking bonds.

- A girl pours a spoonful of sugar into a glass of warm water. She stirs the water until the sugar disappears. When she tastes the water, she notices that it is now sweet. Which describes the kind of matter in the glass?
  - a compound
  - an element
  - a solution
  - a substance
- How could you separate a mixture of stone and wooden beads that are all the same size?
  - Add water to the mixture and skim off the wooden beads, which float.
  - Heat the mixture until the stone beads melt.
  - Strain the mixture to separate out the stone beads.
  - Use a magnet to pull out the wooden beads.

Use the figure below to answer question 7.



- The figure shows models of three different atoms. What can you conclude about the three models shown in the figure?
  - They all show positive ions.
  - They all show negative ions.
  - They all show the same element.
  - They all show the same isotope.



- 8 What is the atomic number of an atom that has 2 electrons, 3 protons, and 4 neutrons?
- A 2  
B 3  
C 4  
D 7

Use the table below to answer questions 9 and 10.

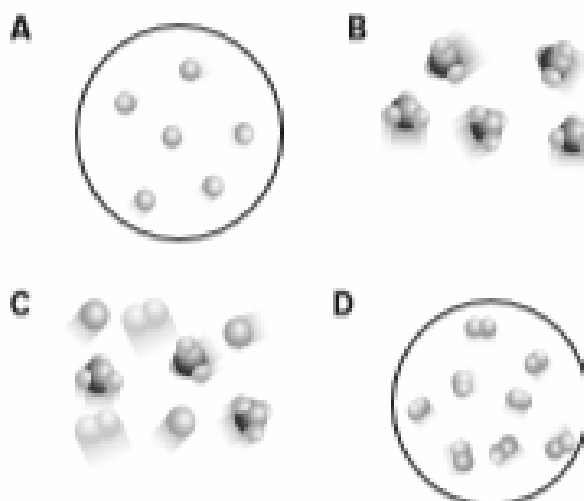
	Number of Protons	Number of Neutrons	Number of Electrons
A	8	8	8
B	8	8	10
C	8	9	8
D	9	10	9

- 9 The table shows the numbers of protons, neutrons, and electrons for four atoms. Which atom has a negative charge?
- A A  
B B  
C C  
D D
- 10 Which of the atoms is a different element than the others?
- A A  
B B  
C C  
D D

## Constructed Response

- 11 How do protons, electrons, and neutrons differ in charge and location in the atom?

Use the figures below to answer questions 12 and 13.



- 12 Classify each model A–D as either an element, a compound, or a mixture. Explain your reasoning for each answer.
- 13 Imagine that samples A and D were reacted and formed a compound. Then imagine that the same samples were combined to form a mixture. How would the two combinations differ?
- 14 Suppose a neutral atom has 5 protons, 5 neutrons, and 5 electrons. List the number of protons, electrons, and neutrons for the following.
- a positive ion of the same element
  - a negative ion of the same element
  - a neutral isotope of the same element

## Multiple Choice

- 1 D—Correct.** A is the number of molecules, B is the number of different elements, C is the number of atoms of one type of element in the molecule.
- 2 A—Correct.** B and C would have to show more than one type of particle, D would have to have atoms of all the same type.
- 3 B—Correct.** A has molecules of all the same type and is therefore evenly mixed. C and D describe the same type of evenly mixed mixture.
- 4 C—Correct.** A describes an element, B could describe both compounds and mixtures, and D describes only mixtures.
- 5 C—Correct.** A would not involve parts of the mixture having the same property or sweetness before and after combining, B would involve only one kind of matter, and D describes elements and compounds but not mixtures.
- 6 A—Correct.** B would not work because the wooden beads would be destroyed by temperatures high enough to melt stone. C would work only on beads of different sizes. D would not work because stone and wood are not magnetic materials.
- 7 C—Correct.** A and B are incorrect because none of the models are ions, they all have just one proton and one electron, which means the atom does not have a charge. D is incorrect because the models show different isotopes of the same element, not the same isotope.
- 8 B—Correct.** A can be used to determine charge, C can be used to determine isotope number, and D is the mass number.
- 9 B—Correct.** A, C, and D have the same numbers of protons and electrons and are thus neutral.
- 10 D—Correct.** A, B, and C have the same number of protons and different numbers of neutrons, which makes them isotopes of one another.

## Constructed Response

- 11** Protons have positive charges and are located in the nucleus. Electrons have negative charges and are located in a cloud around the nucleus. Neutrons have no charge and are located in the nucleus.
- 12** Samples A and D are elements because their particles are made up of one kind of atom. Sample B is a compound because its particles are all the same but they are made up of more than one kind of atom. Sample C is a mixture because its particles are different.
- 13** Sample answer: The model for the compound would show that all the particles are the same. Each molecule would have at least one of each type of atom. The model for the mixture would show the original particles randomly mixed. No new combinations of atoms (bonds) would be shown.
- 14** A positive ion would have 5 protons, 5 neutrons, and 4 electrons. A negative ion would have 5 protons, 5 neutrons, and 6 electrons. A neutral isotope could have 5 protons, 5 electrons and X neutrons, where  $X > 5$ .



## 5.1 Matter and Its Properties

- Particles of a **solid** vibrate about a definite position. Particles of a **liquid** can slide past one another. Particles of a **gas** move freely within their container.
- A **physical property** is a characteristic of matter that you can observe without changing the identity of the substances that make it up. A **chemical property** is the ability or inability of a substance to combine with or change into one or more new substances.
- Some properties of matter do not depend on size or amount of the sample. You can identify a substance by comparing these properties to those of other known substances.



volume  
solid  
liquid  
gas  
physical property  
mass  
density  
solubility  
chemical property

## 5.2 Matter and Its Changes

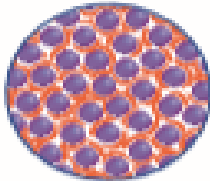
- A change in the size, shape, form, or state of matter in which the identity of the matter stays the same is a **physical change**. A change in matter in which the substances that make it up change into other substances with different chemical and physical properties is a **chemical change**.
- The **law of conservation of mass** states that the total mass before a chemical reaction is the same as the total mass after the reaction.

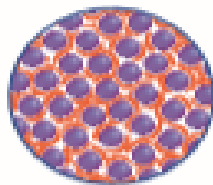


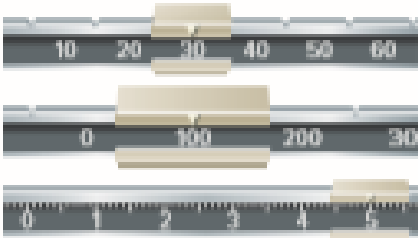
physical change  
chemical change  
law of conservation  
of mass

# 5 Review

## Understand Key Concepts

- Which is a property of all solids?
  - Particles are far apart.
  - Particles vibrate in all directions.
  - Volume and shape can easily change.
  - Weak forces exist between particles.
- Which characteristic is a chemical property?
  - highly flammable
  - mass of 15 kg
  - woolly texture
  - golden color
- Which property of an object depends on its location?
  - density
  - mass
  - volume
  - weight
- How are the particles of a gas different from the particles of a liquid shown here?
 



- They move more slowly.
  - They are farther apart.
  - They have less energy.
  - They have stronger attractions.
- Which is a physical change?
    - burning natural gas
    - chopping onions
    - digesting food
    - exploding dynamite
  - Which stays the same when a substance changes from a liquid to a gas?
    - density
    - mass
    - forces between particles
    - distance between particles
  - Which is a chemical change?
    - boiling water
    - copper turning green in air
    - freezing fruit juice
    - slicing a potato
  - Which would be most useful for identifying an unknown liquid?
    - density
    - mass
    - volume
    - weight
  - What mass is measured on this balance?
 
    - 35 g
    - 45 g
    - 135 g
    - 145 g
  - What causes a chemical reaction when you prepare scrambled eggs?
    - removing the eggs from the shells
    - mixing the egg yolks and the egg whites together
    - heating the eggs in a pan
    - sprinkling pepper onto the cooked eggs
  - Which describes the formation of a precipitate?
    - A gas forms when a solid is placed in a liquid.
    - A liquid forms when a block of metal is heated.
    - A solid forms when one liquid is poured into another.
    - Bubbles form when an acid is poured onto a rock.

## Critical Thinking

12. **Apply** Suppose you find a gold-colored ring. Explain why you could use some physical properties but not others to determine whether the ring is actually made of gold.

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13. **Reason** You make lemonade by mixing lemon juice, sugar, and water. Is this a physical change or a chemical change? Explain.

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14. **Give an example** of a physical change you might observe at your school that is reversible and a physical change that is not reversible.

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15. **Defend** A classmate defines a liquid as any substance that can be poured. Use the picture below to explain why this is not an acceptable definition.



16. **Suggest** a way that you could use displacement to determine the volume of a rock that is too large to fit into a graduated cylinder.

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17. **Hypothesize** A scientist measures the mass of two liquids before and after combining them. The mass after combining the liquids is less than the sum of the masses before. Where is the missing mass?

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## Writing in Science

18. Write a four-sentence description of an object in your home or classroom. Be sure to identify both physical properties and chemical properties of the object.



## The BIG Idea

19. What gives a substance its unique identity?
20. What are some physical and chemical properties that an airplane manufacturer must consider when choosing materials to be used in constructing the shell of the aircraft shown below?

## Math Skills

21. Use what you have learned about density to complete the table below. Then, determine the identities of the two unknown metals.

Metal	Mass (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
Iron	42.5	5.40	
Lead	28.8	2.55	
Tungsten	69.5	3.60	
Zinc	46.4	6.50	
	61.0	5.40	
	46.4	2.40	

## Understand Key Concepts

- 1 B. Particles vibrate in all directions.
- 2 A. highly flammable
- 3 D. weight
- 4 B. They are farther apart.
- 5 B. chopping onions
- 6 C. mass
- 7 B. copper turning green in air
- 8 A. density
- 9 C. 135 g
- 10 C. heating the eggs in a pan
- 11 C. A solid forms when one liquid is poured into another.

## Critical Thinking

- 12 Possible answer: Mass, volume, and color are not reliable for identifying a substance because they can change. Density would be a more reliable property for identifying the substance used to make the ring because it does not change. Melting point would not be a reasonable property because it would probably be too high to measure.
- 13 It is a physical change because the substances are combined but still have the same identity.
- 14 Possible answers: A reversible physical change is a classroom being painted a different color. An irreversible change is a pencil breaking.
- 15 Possible answer: Although liquids can be poured, substances made of small bits of solids, such as sand, can also be poured.
- 16 Possible answer: First, pour a known amount of liquid into a large container, place the rock into the liquid, and mark the new level of the liquid. Next, remove the rock and determine the amount of liquid you have to add to the container to reach that level.
- 17 Combining the liquids must have produced a gas. The mass of the gas equals the difference in mass before and after combining the liquids.



- 18** Possible answers might include describing a pencil that has the physical properties of long, thin, and orange, and the chemical property of being flammable because it is made of wood.
- 19** Every substance has both physical and chemical properties. Physical properties, such as density and melting point, and chemical properties, such as flammability and ability to rust, give a substance its unique identity.
- 20** Possible answers: the density of the metal used on the outside of the aircraft; whether the metal will rust or react in some other way to water or oxygen; and whether the metal is malleable.

**21**

<b>Metal</b>	<b>Mass (g)</b>	<b>Volume (cm<sup>3</sup>)</b>	<b>Density (g/cm<sup>3</sup>)</b>
Iron	42.5	5.40	<b>7.87</b>
Lead	28.8	2.55	<b>11.3</b>
Tungsten	69.5	3.60	<b>19.3</b>
Zinc	46.4	6.50	<b>7.14</b>
<b>Lead</b>	61.0	5.40	<b>11.3</b>
<b>Tungsten</b>	46.4	2.40	<b>19.3</b>

## Multiple Choice

- 1 Which describes the particles in a substance with no definite volume or shape?
- A Particles are close but can move freely.
  - B Particles are close but can vibrate in all directions.
  - C Particles are far apart and cannot move.
  - D Particles are far apart and move freely.

- 2 Which diagram shows a chemical change?

A



B



C



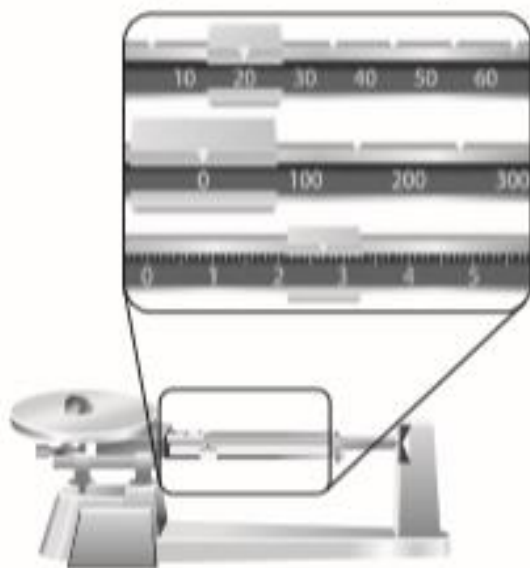
D



- 3 Which is NOT true about firewood that burns completely?

- A Ashes and gases form from the substances in the wood.
- B Oxygen from the air combines with substances in the wood.
- C The total mass of substances in this process decreases.
- D The wood gives off thermal energy and light.

Use the diagram below to answer question 4.



- 4 What is the mass of the object on the balance scale?

- A 22 g
  - B 22.5 g
  - C 22.7 g
  - D 30 g
- 5 Which is true when an ice cube melts?
- A Volume and mass increase.
  - B Volume and mass do not change.
  - C Volume decreases, but mass does not change.
  - D Volume increases, but mass decreases.
- 6 What is the BEST way to separate and save the parts of a sand-and-water mixture?
- A Boil the mixture and collect the steam.
  - B Pour the mixture through a filter that only the water can pass through.
  - C Lift the sand out of the mix with a spoon.
  - D Pour a strong acid into the mixture to dissolve the sand.

Use the table below to answer questions 7 and 8.

Action	Time	Result
Heated	30 minutes	solid
Heated	60 minutes	liquid
Not heated	30 minutes	solid
Not heated	60 minutes	solid

- 7 Based on the results of this experiment, what can you conclude about heating this unknown substance?
- A Heating melted it in 30 minutes.
  - B Heating melted it in 60 minutes.
  - C Heating made it solid in 60 minutes.
  - D Heating caused no changes.
- 8 What can you conclude about the original state of the substance?
- A It is part solid and part liquid.
  - B It is a liquid.
  - C It is a solid.
  - D It is part liquid and part gas.
- 9 Which is a sign of a physical change?
- A Bread gets moldy with age.
  - B Ice forms on a puddle in winter.
  - C The metal on a car starts to rust.
  - D Yeast causes bread dough to rise.

## Constructed Response

Use the table below to answer questions 10-13.

Properties	Substance 1	Substance 2	Substance 3
Color	yellow	yellow	yellow
State	solid	solid	solid
Mass	217 g	217 g	75 g
Melting point	505°C	230°C	505°C
Density	3.78 g/cm <sup>3</sup>	2.76 g/cm <sup>3</sup>	3.78 g/cm <sup>3</sup>
Flammable	yes	yes	yes

- 10 Identify each property of the unknown substances as either chemical or physical. Explain your reasoning.
- 11 Of the three unknown substances tested, two are the same substance and one is different. Which two substances do you think are the same? Explain your reasoning.
- 12 Which properties in the table helped you determine your answer in number 11? Which properties were not helpful? Explain your reasoning.
- 13 What additional physical and chemical properties of substances might the table have included?

## Multiple Choice

- 1 D—Correct.** A, B, C—The question describes a gas, which has no definite volume or shape. Its particles are far apart, moving freely within a container, because no attractive forces hold them together.
- 2 C—Correct.** A, B, D—When a substance undergoes a chemical change, it becomes a different substance with different physical and chemical properties. For example, when a wooden match burns, the wood changes into other substances, including carbon dioxide and ash. The physical properties of the paper, balloon, and fruit do not change when they undergo cutting, emptying, and peeling respectively.
- 3 C—Correct.** A, B, D—When wood burns, it changes into other substances, including carbon dioxide, water vapor, and ash. However, total mass in this, or any chemical change, does not change; that is, the combined mass of the new substances is equal to that of the wood. This is known as the law of conservation of mass.
- 4 C—Correct.** A, B, D—The scale has three measurement indicators (ones units—bottom, tens units—top, hundreds units—middle). The mass of the object on the scale can be calculated by adding the unit measurements. Mass = the ones units (2.7) + the tens units (20) and the hundreds units (0).  $2.7 + 20 + 0 = 22.7$  g.
- 5 C—Correct.** A, B, D—When water changes state from solid to liquid, its volume decreases; that is, the ice cube occupies a greater space than the liquid water. Because matter is always conserved, however, mass does not change. Therefore, the mass of the ice cube is equal to that of the liquid water.
- 6 B—Correct.** A, C, D—Physical properties are useful in separating materials in a mixture. Because water can be separated from sand by going through filter paper, the mixture can be filtered for separation.
- 7 B—Correct.** A, C, D—The table shows that the substance, a solid, melted, or changed to a liquid, in 60 minutes when heat was applied.
- 8 C—Correct.** A, B, D—According to the table, in its original state—that is, when no change agent such as heat is applied—the substance is a solid.
- 9 B—Correct.** A, C, D—In a physical change, only the state of matter is affected. Of the answers, the only physical change is the formation of ice on a puddle of water. (Water changes from a liquid to a solid—ice.) The other answer choices reflect chemical changes because both the physical and chemical properties of the original substances change.

- 10** Color, state, mass, melting point, and density are all physical properties that can be observed without interaction with another substance. Flammability is a chemical property because it is observable when the substance reacts with or changes to a different substance.
- 11** Samples 1 and 3 could be the same substance because they have the same melting point and density. Color, state, mass, and flammability are not useful for determining the identity.
- 12** Melting point and density were useful for comparing the substances because they do not depend on the sample size or amount. The color, state, flammability, and mass were not useful for comparing the substances. Color and flammability were not useful because all three substances have the same color, state, and flammability. Mass was not useful, because mass depends on the amount of a substance present.
- 13** Additional physical properties of substances include malleability, electrical conductivity, magnetism, solubility, volume, and boiling point. Malleability is the ability of the substance to be rolled or hammered into thin sheets. Electrical conductivity is a substance's ability to transmit an electric charge. Magnetism allows a substance to attract certain metals. Solubility is the ability of one material to dissolve in another. The volume of a liquid can be measured with a graduated cylinder and reading the volume mark. The boiling point of a substance is the temperature at which a liquid changes to a gas. An additional chemical property of a substance includes the ability to rust.

