SECTION 1

Physical and Chemical Properties

As You Read

What You'll Learn

- **Identify** physical and chemical properties of matter.

Vocabulary

physical property
chemical property

Why It's Important

Understanding the different properties of matter will help you to better describe the world around you.

Physical Properties

It's a busy day at the state fair as you and your classmates navigate your way through the crowd. While you follow your teacher, you can't help but notice the many sights and sounds that surround you. Eventually, you fall behind the group as you spot the most amazing ride you have ever seen. You inspect it from one end to the other. How will you describe it to the group when you catch up to them? What features will you use in your description?

Perhaps you will mention that the ride is large, blue, and made of wood. These features are all physical properties, or characteristics, of the ride. A **physical property** is a characteristic you can observe without changing or trying to change the composition of the substance. How something looks, smells, sounds, or tastes are all examples of physical properties. Look at **Figure 1.** You can describe all types of matter and differentiate between them by observing their properties.

Reading Check *What is a physical property of matter?*

Figure 1
All matter can be described by physical properties that can be observed using the five senses. *What types of matter do you think you could see, hear, taste, touch, and smell at the fair?*

Using Your Senses Some physical properties describe the appearance of matter. You can detect many of these properties with your senses. For example, you can see the color and shape of the ride at the fair. You can also touch it to feel its texture. You can smell the odor or taste the flavor of some matter. (You should never taste anything in the laboratory.) Consider the physical properties of the items in **Figure 2.**

State To describe a sample of matter, you need to identify its state. Is the ride a solid, a liquid, or a gas? This property, known as the state of matter, is another physical property that you can observe. The ride, your chair, a book, and a pen are examples of matter in the solid state. Milk, gasoline, and vegetable oil are examples of matter in the liquid state. The helium in a balloon, air in a tire, and neon in a sign are examples of matter in the gas state. You can see examples of solids, liquids, and gases in **Figure 3.**

Perhaps you are most familiar with the three states of water. You can drink or swim in liquid water. You use the solid state of water, which is ice, when you put the solid cubes in a drink or skate on a frozen lake. Although you can't see it, water in the gas state is all around you in the air.

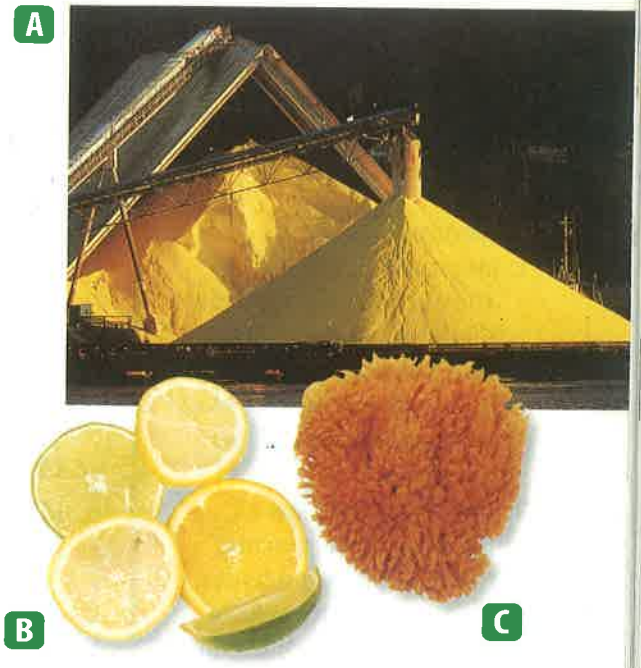
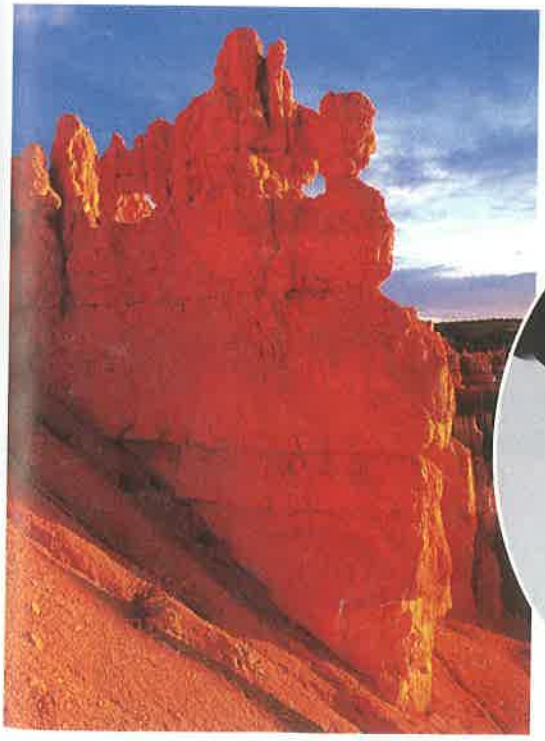


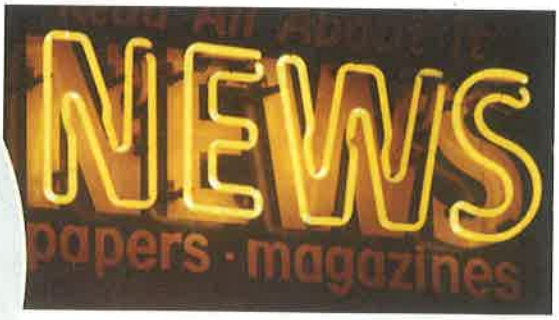
Figure 2
A Some matter has a characteristic color, such as this sulfur pile. B You can use a characteristic smell or taste to identify these fruits. C Even if you didn't see it, you could probably identify this sponge by feeling its texture.

Figure 3
The state of a sample of matter is an important physical property.



A This rock formation is in the solid state.

B The oil flowing out of a bottle is in the liquid state.



C This colorful sign uses the element neon, which is generally found in the gas state.

Mini LAB

Measuring Properties

Procedure

1. Measure the mass of a **10-mL graduated cylinder.**
2. Fill the graduated cylinder with **water** to the 10-mL mark and measure the mass of the graduated cylinder and water.
3. Determine the mass of the water by subtracting the mass of the graduated cylinder from the mass of the graduated cylinder and water.
4. Determine the density of water by dividing the mass of the water by the volume of the water.

Analysis

1. Why did you need to measure the mass of the empty graduated cylinder?
2. How would your calculated density be affected if you added more than 10-mL of water?

Size Dependent Properties Some physical properties depend on the size of the object. Suppose you need to move a box. The size of the box would be important in deciding if you need to use your backpack or a truck. You can begin by measuring the width, height, and depth of the box. If you multiply them together, you calculate the box's volume. The volume of an object is the amount of space it occupies.

Another physical property that depends on size is mass. Recall that the mass of an object is a measurement of how much matter it contains. A bowling ball has more mass than a basketball. Weight is a measurement of force. Weight depends on the mass of the object and on gravity. If you were to travel to other planets, your weight would change but your size and mass would not. Weight is measured using a spring scale like the one in **Figure 4.**

Size Independent Properties Another physical property, density, does not depend on the size of an object. Density measures the amount of mass in a given volume. To calculate the density of an object, divide its mass by its volume. The density of water is the same in a glass as it is in a tub. Another property, solubility, also does not depend on size. Solubility is the number of grams of one substance that will dissolve in 100 g of another substance at a given temperature. The amount of drink mix that can be dissolved in 100 g of water is the same in a pitcher as it is when it is poured into a glass. Size dependent and independent properties are shown in **Table 1.**

Melting and Boiling Point Melting and boiling point also do not depend upon an object's size. The temperature at which a solid changes into a liquid is called its melting point. The temperature at which a liquid changes into a gas is called its boiling point. The melting and boiling points of several substances, along with some of their other physical properties, are shown in **Table 2.**

Figure 4
A spring scale is used to measure an object's weight.

Table 1 Properties of Matter

	Physical Properties
Dependent on sample size	mass, weight, volume
Independent of sample size	density, melting/boiling point, solubility, ability to attract a magnet, state of matter, color.

Table 2 Physical Properties of Several Substances (at atmospheric temperature and pressure)

Substance	Color	State	Density (g/cm^3)	Melting Point (°C)	Boiling Point (°C)
Bromine	Red-brown	Liquid	3.12	−7	59
Chlorine	Yellowish	Gas	0.0032	−101	−34
Mercury	Silvery-white	Liquid	13.5	−39	357
Neon	Colorless	Gas	0.0009	−249	−246
Oxygen	Colorless	Gas	0.0014	−219	−183
Sodium chloride	White	Solid	2.17	801	1,413
Sulfur	Yellow	Solid	2.07	115	445
Water	Colorless	Liquid	1.00	0	100

Behavior Some matter can be described by the specific way in which it behaves. For example, some materials pull iron toward them. These materials are said to be magnetic. The lodestone in **Figure 5** is a rock that is naturally magnetic.

Other materials can be made into magnets. You might have magnets on your refrigerator or locker at school. The door of your refrigerator also has a magnet within it that holds the door shut tightly.

Reading Check *What are some examples of physical properties of matter?*

Figure 5
This lodestone attracts certain metals to it. Lodestone is a natural magnet.

Earth Science
INTEGRATION

Scientists can learn about the history of the Moon by analyzing the properties of moon rocks. The properties of some moon rocks, for example, are similar to those of rocks produced by volcanoes on Earth. In this way, scientists learned that the Moon once had volcanic activity. Make a list of questions to ask about the properties of a moon rock.

Figure 6
Notice the difference between the new matches and the matches that have been burned. The ability to burn is a chemical property of matter.

SCIENCE Online

Research Visit the Glencoe Science Web site at **science.glencoe.com** for more information about methods of measuring matter. Make a poster showing how to make measurements involving several different samples of matter.

Chemical Properties

Some properties of matter cannot be identified just by looking at a sample. For example, nothing happens if you look at the matches in **Figure 6A.** But if someone strikes the matches on a hard, rough surface they will burn, as shown in **Figure 6B.** The ability to burn is a chemical property. A **chemical property** is a characteristic that cannot be observed without altering the substance. As you can see in **Figure 6C,** the matches are permanently changed after they are burned. Therefore this property can be observed only by changing the composition of the match. Another way to define a chemical property, then, is the ability of a substance to undergo a change that alters its identity. You will learn more about changes in matter in the following section.

Section 1 Assessment

1. What physical properties could you use to describe a baseball?
2. How are your senses important to identifying physical properties of matter?
3. How is density related to mass and volume? Explain and write an equation.
4. Describe a chemical property in your own words. Give an example.
5. **Think Critically** Explain why density and solubility are size-independent physical properties of matter.

Skill Builder Activities

6. **Comparing and Contrasting** How is a chemical property different from a physical property? **For more help, refer to the Science Skill Handbook.**
7. **Solving One-Step Equations** You need to fill a bucket with water. The volume of the bucket is 5 L and you are using a cup with a volume of 50 mL. How many cupfuls will you need? There's a hint: *1 L = 1000 mL.* **For more help, refer to the Math Skill Handbook.**