

Physical and Chemical Properties

as you read

What You'll Learn

- Identify physical and chemical properties of matter.
- Classify objects based on physical properties.

Why It's Important

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

Review Vocabulary

matter: anything that has mass and takes up space

New Vocabulary

- physical property
- chemical property

Physical Properties

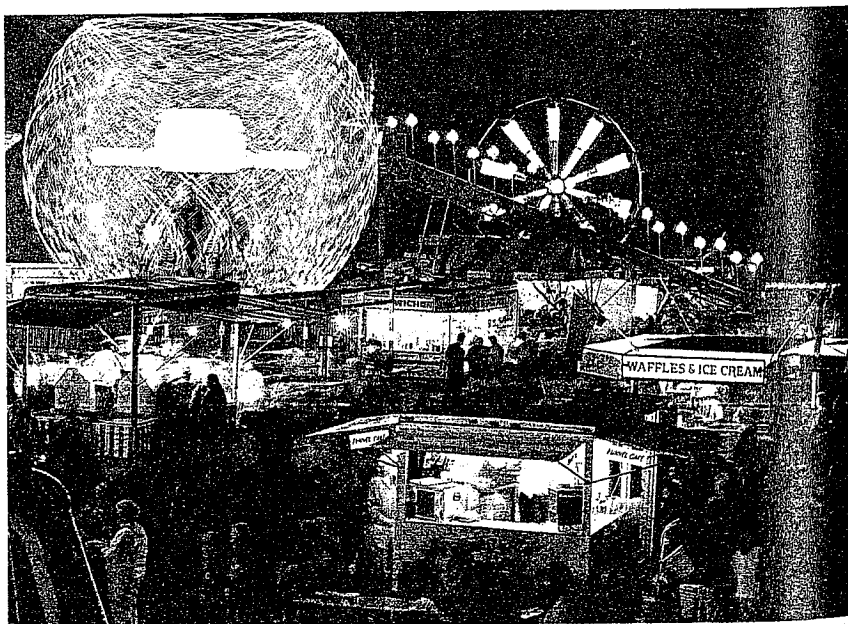
It's a busy day at the state fair as you and your classmates navigate your way through the crowd. While you follow your teacher, you can't help but notice the many sights and sounds that surround you. Eventually, you fall behind the group as you spot the most amazing ride you have ever seen. You inspect 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 that 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. In **Figure 1** you can describe and differentiate all types of matter 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.

Identify the types of matter 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 ice 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.

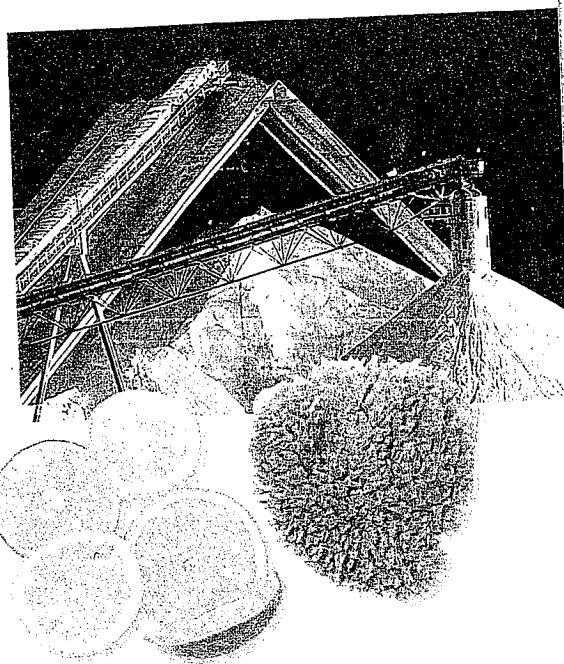


Figure 2 Some matter has a characteristic color, such as this sulfur pile. You can use a characteristic smell or taste to identify these fruits. Even if you didn't see it, you could probably identify this sponge by feeling its texture.

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



This rock formation is in the solid state.



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



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



Measuring Properties

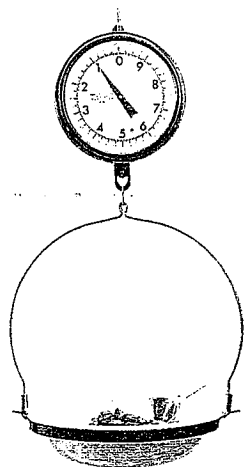
Procedure

1. Measure the mass of a 10-mL graduated cylinder.
2. Fill the graduated cylinder with water to the 10-mL mark and remeasure the mass of the graduated cylinder with the 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?

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



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 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. The density of an object will change, however, if the mass changes and the volume remains the same. 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**.

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

Substance	State	Density (g/cm ³)	Melting point (°C)	Boiling point (°C)	Solubility in cold water (g/100 mL)
Ammonia	gas	0.7710	-78	-33	89.9
Bromine	liquid	3.12	-7	59	4.17
Calcium carbonate	solid	2.71	1,339	898	0.0014
Iodine	solid	4.93	113.5	184	0.029
Potassium hydroxide	solid	2.044	360	1,322	107
Sodium chloride	solid	2.17	801	1,413	35.7
Water	liquid	1	0	100	—

Magnetic Properties 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?*

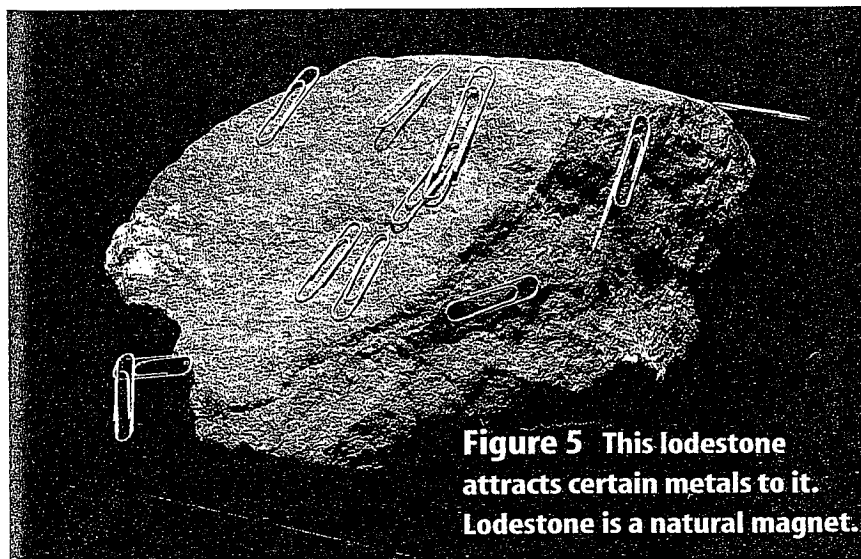


Figure 5 This lodestone attracts certain metals to it. Lodestone is a natural magnet.



Identifying an Unknown Substance

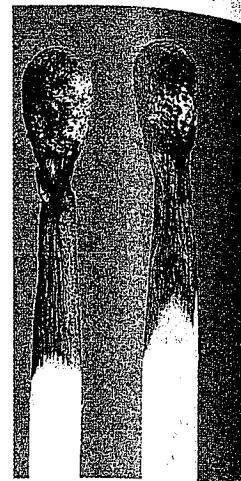
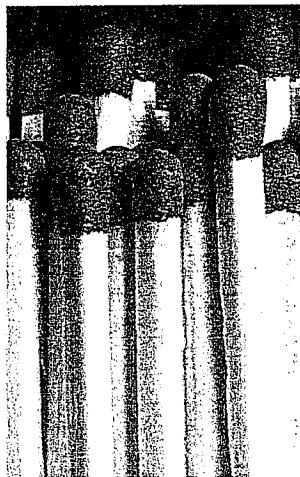
Procedure

1. Obtain data from your teacher (mass, volume, solubility, melting or boiling point) for an unknown substance(s).
2. Calculate density and solubility in units of g/100 mL for your unknown substance(s).
3. Using Table 2 and the information you have, identify your unknown substance(s).

Analysis

1. Describe the procedure used to determine the density of your unknown substance(s).
2. Identify three characteristics of your substance(s).
3. Explain how the solubility of your substance would be affected if the water was hot.

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.



Topic: Measuring Matter

Visit green.msscience.com for Web links to information about methods of measuring matter.

Activity Find an object around the house. Use two methods of measuring matter to describe it.

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 the first picture. But if someone strikes the matches on a hard, rough surface they will burn, as shown in the second picture. 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 the last picture, 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 review

Summary

Physical Properties

- Matter exists in solid, liquid, and gaseous states.
- Volume, mass, and weight are size-dependent properties.
- Properties such as density, solubility, boiling and melting points, and ability to attract a magnet are size-independent.
- Density relates the mass of an object to its volume.

Chemical Properties

- Chemical properties have characteristics that cannot be observed without altering the identity of the substance.

Self Check

1. **Infer** How are your senses important for identifying physical properties of matter?
2. **Describe** the physical properties of a baseball.
3. **Think Critically** Explain why solubility is a size-independent physical property.
4. **Compare and Contrast** How do chemical and physical properties differ?

Applying Math

5. **Solve One-Step Equations** The volume of a bucket is 5 L and you are using a cup with a volume of 50 mL. How many cupfuls will you need to fill the bucket?
Hint: 1 L = 1,000 mL