

Compounds

What do salt, sugar, baking soda, and water have in common? You might use all of these to bake bread. Is there anything else similar about them?

Salt, sugar, baking soda, and water are all compounds. Because most elements take part in chemical changes fairly easily, they are rarely found alone in nature. Instead, they are found combined with other elements as compounds.

Compounds: Made of Elements

A **compound** is a pure substance composed of two or more elements that are chemically combined. Elements combine by reacting, or undergoing a chemical change, with one another. A particle of a compound is a molecule. Molecules of compounds are formed when atoms of two or more elements join together.

In **Figure 1**, you see magnesium reacting with oxygen. A compound called *magnesium oxide* is forming. The compound is a new pure substance. It is different from the elements that make it up. Most of the substances that you see every day are compounds. **Table 1** lists some familiar examples.

The Ratio of Elements in a Compound

Elements do not randomly join to form compounds. Elements join in a specific ratio according to their masses to form a compound. For example, the ratio of the mass of hydrogen to the mass of oxygen in water is 1 to 8. This mass ratio can be written as 1:8. This ratio is always the same. Every sample of water has a 1:8 mass ratio of hydrogen to oxygen. What happens if a sample of a compound has a different mass ratio of hydrogen to oxygen? The compound cannot be water.

Table 1 Familiar Compounds

Compound	Elements combined
Table salt	sodium and chlorine
Water	hydrogen and oxygen
Vinegar	hydrogen, carbon, and oxygen
Carbon dioxide	carbon and oxygen
Baking soda	sodium, hydrogen, carbon, and oxygen

What You Will Learn

- Explain how elements make up compounds.
- Describe the properties of compounds.
- Explain how a compound can be broken down into its elements.
- Give examples of common compounds.

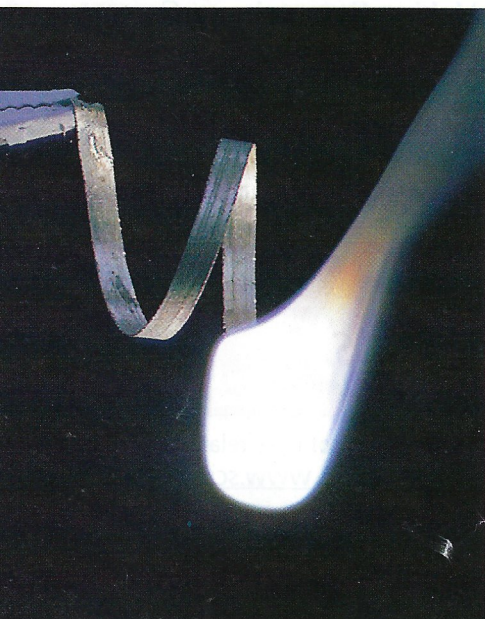
Vocabulary

compound

READING STRATEGY

Prediction Guide Before reading this section, write the title of each heading in this section. Next, under each heading, write what you think you will learn.

Figure 1 As magnesium burns, it reacts with oxygen and forms the compound magnesium oxide.



Quick Lab




Compound Confusion

1. Measure **4 g of compound A**, and place it in a **clear plastic cup**.
2. Measure **4 g of compound B**, and place it in a **second clear plastic cup**.
3. Observe the color and texture of each compound. Record your observations.
4. Add **5 mL of vinegar** to each cup. Record your observations.
5. Baking soda reacts with vinegar. Powdered sugar does not react with vinegar. Which compound is baking soda, and which compound is powdered sugar? Explain your answer.

Properties of Compounds

As an element does, each compound has its own physical properties. Physical properties include melting point, density, and color. Compounds can also be identified by their different chemical properties. Some compounds react with acid. For example, calcium carbonate, found in chalk, reacts with acid. Other compounds, such as hydrogen peroxide, react when exposed to light.

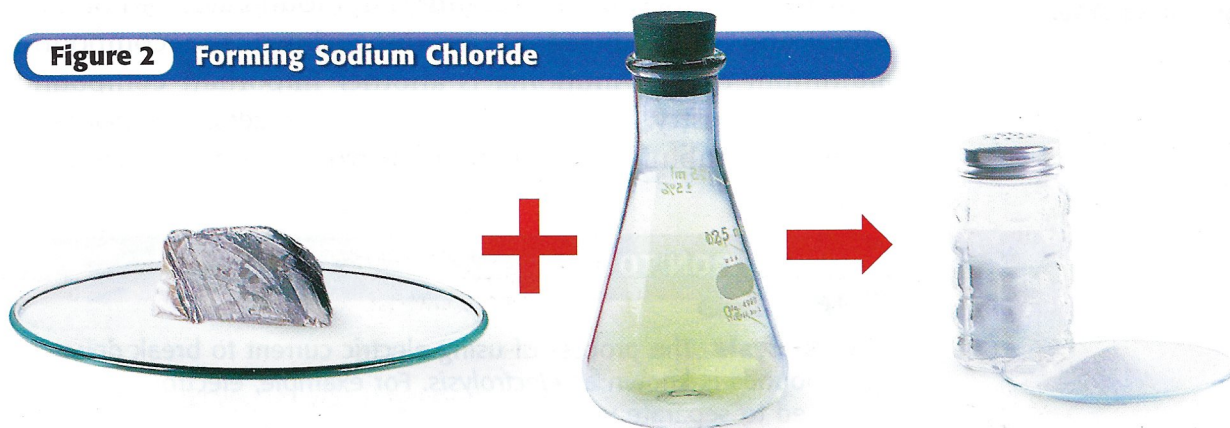
 **Reading Check** What are three physical properties used to identify compounds? (See the Appendix for answers to Reading Checks.)

compound a substance made up of atoms of two or more different elements joined by chemical bonds

Properties: Compounds Versus Elements

A compound has properties that differ from those of the elements that form it. Look at **Figure 2**. Sodium chloride, or table salt, is made of two very dangerous elements—sodium and chlorine. Sodium reacts violently with water. Chlorine is a poisonous gas. But when combined, these elements form a harmless compound with unique properties. Sodium chloride is safe to eat. It also dissolves (without exploding!) in water.

Figure 2 Forming Sodium Chloride



Sodium is a soft, silvery white metal that reacts violently with water.

Chlorine is a poisonous, greenish yellow gas.

Sodium chloride, or table salt, is a white solid. It dissolves easily in water and is safe to eat.

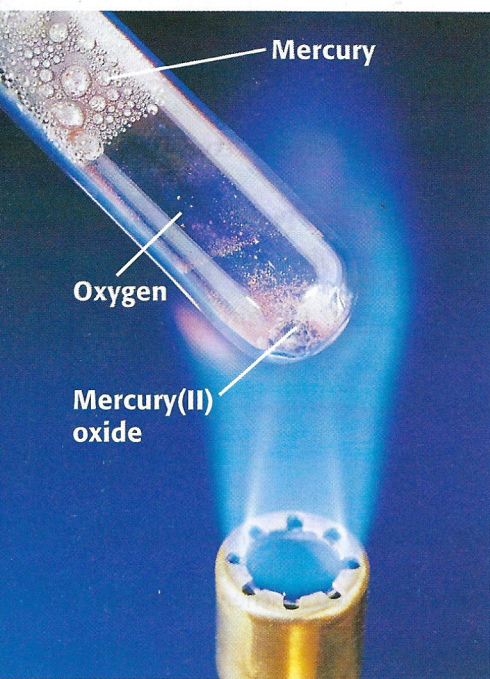



Figure 3 Heating mercury(II) oxide causes a chemical change that separates it into the elements mercury and oxygen.

Breaking Down Compounds

Some compounds can be broken down into their elements by chemical changes. Other compounds break down to form simpler compounds instead of elements. These simpler compounds can then be broken down into elements through more chemical changes. For example, carbonic acid is a compound that helps give carbonated beverages their “fizz.” When you open a carbonated beverage, carbonic acid breaks down into carbon dioxide and water. Carbon dioxide and water can then be broken down into the elements carbon, oxygen, and hydrogen through chemical changes.

 **Reading Check** Compounds can be broken down into what two types of substances?

Methods of Breaking Down Compounds

The only way to break down a compound is through a chemical change. Sometimes, energy is needed for a chemical change to happen. Two ways to add energy to break down a compound are to apply heat and to apply an electric current. For example, heating the compound mercury(II) oxide breaks it down into the elements mercury and oxygen, as shown in **Figure 3**.

Compounds in Your World

You are surrounded by compounds. Compounds make up the food you eat, the school supplies you use, and the clothes you wear—even you!

Compounds in Industry

The compounds found in nature are not usually the raw materials needed by industry. Often, these compounds must be broken down to provide elements or other compounds that can be used as raw material. For example, aluminum is used in cans and airplanes. But aluminum is not found alone in nature. Aluminum is produced by breaking down the compound aluminum oxide. Ammonia is another important compound used in industry. It is used to make fertilizers. Ammonia is made by combining the elements nitrogen and hydrogen.

CONNECTION TO Physics

Electrolysis The process of using electric current to break down compounds is known as *electrolysis*. For example, electrolysis can be used to separate water into hydrogen and oxygen. Research ways that electrolysis is used in industry. Make a poster of what you learn, and present a report to your class.

ACTIVITY

INTERNET ACTIVITY

For another activity related to this chapter, go to go.hrw.com and type in the keyword **HP5MIXW**.

Compounds in Nature

Proteins are compounds found in all living things. The element nitrogen is one of the elements needed to make proteins. **Figure 4** shows how some plants get the nitrogen they need. Other plants use nitrogen compounds that are in the soil. Animals get the nitrogen they need by eating plants or by eating animals that have eaten plants. The proteins in the food are broken down as an animal digests the food. The simpler compounds that form are used by the animal's cells to make new proteins.

Another compound that plays an important role in life is carbon dioxide. You exhale carbon dioxide that was made in your body. Plants take in carbon dioxide, which is used in photosynthesis. Plants use photosynthesis to make compounds called carbohydrates. These carbohydrates can then be broken down for energy through other chemical changes by plants or animals.



Figure 4 The bumps on the roots of this pea plant are home to bacteria that form compounds from nitrogen in the air. The pea plant makes proteins from these compounds.

SECTION Review

Summary

- A compound is a pure substance composed of two or more elements.
- The elements that form a compound always combine in a specific ratio according to their masses.
- Each compound has a unique set of physical and chemical properties that differ from those of the elements that make up the compound.
- Compounds can be broken down into simpler substances only by chemical changes.

Using Key Terms

1. In your own words, write a definition for the term *compound*.

Understanding Key Ideas

2. The elements in a compound
 - a. join in a specific ratio according to their masses.
 - b. combine by reacting with one another.
 - c. can be separated by chemical changes.
 - d. All of the above
3. What type of change is needed to break down a compound?

Math Skills

4. Table sugar is a compound made of carbon, hydrogen, and oxygen. If sugar contains 41.86% carbon and 6.98% hydrogen, what percentage of sugar is oxygen?

Critical Thinking

5. **Applying Concepts** Iron is a solid, gray metal. Oxygen is a colorless gas. When they chemically combine, rust is made. Rust has a reddish brown color. Why is rust different from the iron and oxygen that it is made of?
6. **Analyzing Ideas** A jar contains samples of the elements carbon and oxygen. Does the jar contain a compound? Explain your answer.

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