SECTION 3

Compounds and Mixtures

Substances

Scientists classify matter in several ways that depend on what it is made of and how it behaves. For example, matter that has the same composition and properties throughout is called a **substance.** Elements, such as a bar of gold or a sheet of aluminum, are substances. When different elements combine, other substances are formed.

As You Read

What You'll Learn

- **Identify** the characteristics of a compound.
- **Compare and contrast** different types of mixtures.

Vocabulary

substance
compound
mixture

Why It's Important

The food you eat, the materials you use, and all matter can be classified by these terms.

Compounds What do you call the colorless liquid that flows from the kitchen faucet? You probably call it water, but maybe you've seen it written H_2O. The elements hydrogen and oxygen exist as separate, colorless gases. However, these two elements can combine, as shown in **Figure 23,** to form the compound water, which is different from the elements that make it up. A **compound** is a substance whose smallest unit is made up of atoms of more than one element bonded together.

Compounds often have properties that are different from the elements that make them up. Water is distinctly different from the elements that make it up. It is also different from another compound made from the same elements. Have you ever used hydrogen peroxide (H_2O_2) to disinfect a cut? This compound is a different combination of hydrogen and oxygen and has different properties.

Water is a nonirritating liquid that is used for bathing, drinking, cooking, and much more. In contrast, hydrogen peroxide carries warnings on its labels such as *Keep Hydrogen Peroxide Out of the Eyes.* Although it is useful in solutions for cleaning contact lenses, it is not safe for your eyes as it comes from the bottle.

Figure 23
A space shuttle is powered by the reaction between liquid hydrogen and liquid oxygen. The reaction produces a large amount of energy and the compound water. *Why would a car that burns hydrogen rather than gasoline be friendly to the environment?*

Figure 24
The elements hydrogen and oxygen can form two compounds—water and hydrogen peroxide. Note the differences in their structure.

Compounds Have Formulas What's the difference between water and hydrogen peroxide? H_2O is the chemical formula for water, and H_2O_2 is the formula for hydrogen peroxide. The formula tells you which elements make up a compound as well as how many atoms of each element are present. Look at **Figure 24.** The subscript number written below and to the right of each element's symbol tells you how many atoms of that element exist in one unit of that compound. For example, hydrogen peroxide has two atoms of hydrogen and two atoms of oxygen. Water is made up of two atoms of hydrogen and one atom of oxygen.

Carbon dioxide, CO_2, is another common compound. Carbon dioxide is made up of one atom of carbon and two atoms of oxygen. Carbon and oxygen also can form the compound carbon monoxide, CO, which is a gas that is poisonous to all warm-blooded animals. As you can see, no subscript is used when only one atom of an element is present. A given compound always is made of the same elements in the same proportion. For example, water always has two hydrogen atoms for every oxygen atom, no matter what the source of the water is. No matter what quantity of the compound you have, the formula of the compound always remains the same. If you have 12 atoms of hydrogen and six atoms of oxygen, the compound is still written H_2O, but you have six molecules of H_2O (6 H_2O), not $H_{12}O_6$. The formula of a compound communicates its identity and makeup to any scientist in the world.

Reading Check ***Propane has three atoms of carbon and eight atoms of hydrogen. What is propane's chemical formula?***

Mini LAB

Comparing Compounds

Procedure

1. Collect the following substances—granular **sugar, rubbing alcohol,** and **salad oil.**
2. Observe the color, appearance, and state of each substance. Note the thickness or texture of each substance.
3. Stir a spoonful of each substance into separate **beakers** of **hot water** and observe.

Analysis

1. Compare the different properties of the substances.
2. The formulas of the three substances are made of only carbon, hydrogen, and oxygen. Infer how they can have different properties.

Mixtures

When two or more substances (elements or compounds) come together but don't combine to make a new substance, a **mixture** results. Unlike compounds, the proportions of the substances in a mixture can be changed without changing the identity of the mixture. For example, if you put some sand into a bucket of water, you have a mixture of sand and water. If you add more sand or more water, it's still a mixture of sand and water. Its identity has not changed. Air is another mixture. Air is a mixture of nitrogen, oxygen, and other gases, which can vary at different times and places. Whatever the proportion of gases, it is still air. Even your blood is a mixture that can be separated, as shown in **Figure 25** by a machine called a centrifuge.

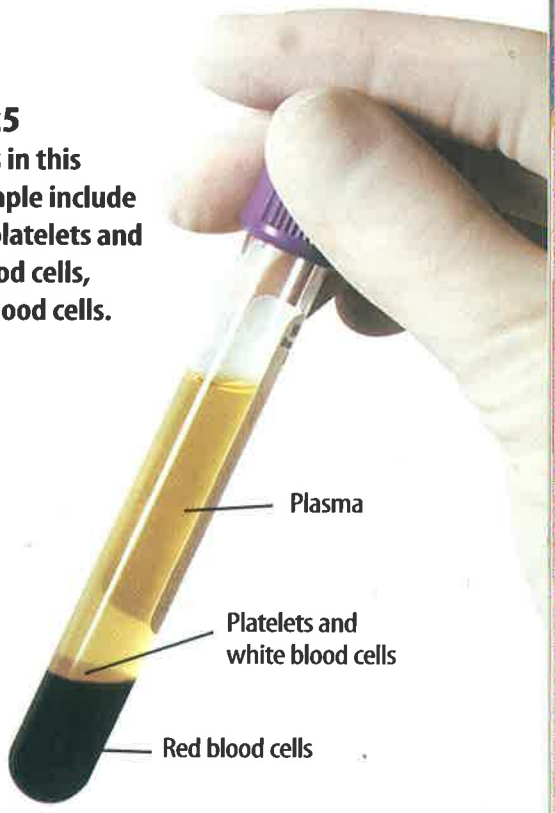

Figure 25
The layers in this blood sample include plasma, platelets and white blood cells, and red blood cells.

Reading Check ***How do the proportions of a mixture relate to its identity?***

Problem-Solving Activity

What's the best way to desalt ocean water?

You can't drink ocean water because it contains salt and other suspended materials. Or can you? In many areas of the world where drinking water is in short supply, methods for getting the salt out of salt water are being used to meet the demand for fresh water. Use your problem solving skills to find the best method to use in a particular area.

Methods for Desalting Ocean Water

Process	Amount of Water a Unit Can Desalt in a Day (m^3)	Special Needs	Number of People Needed to Operate
Distillation	1,000 to 200,000	lots of energy to boil the water	many
Electrodialysis	10 to 4,000	stable source of electricity	1 to 2 persons

Identifying the Problem

The table above compares desalting methods. In distillation, the ocean water is heated. Pure water boils off and is collected, and the salt is left behind. Electrodialysis uses electric current to pull salt particles out of water.

Solving the Problem

1. What method(s) might you use to desalt the water for a large population where energy is plentiful? What method(s) would you chose to use in a single home?

Figure 26
Mixtures are part of your everyday life.

SCIENCE Online

Research Visit the Glencoe Science Web site at **science.glencoe.com** for more information about separating mixtures.

Life Science INTEGRATION

Your blood is a mixture made up of elements and compounds. It contains white blood cells, red blood cells, water, and a number of dissolved substances. The different parts of blood can be separated and used by doctors in different ways. The proportions of the substances in your blood change daily, but the mixture does not change its identity.

Separating Mixtures Sometimes you can use a liquid to separate a mixture of solids. For example, if you add water to a mixture of sugar and sand, only the sugar dissolves in the water. The sand then can be separated from the sugar and water by pouring the mixture through a filter. Heating the remaining solution will separate the water from the sugar.

At other times, separating a mixture of solids of different sizes might be as easy as pouring them through successively smaller sieves or filters. A mixture of marbles, pebbles, and sand could be separated in this way.

Homogeneous or Heterogeneous Mixtures, such as the ones shown in **Figure 26,** can be classified as homogeneous or heterogeneous. *Homogeneous* means "the same throughout." You can't see the different parts in this type of mixture. In fact, you might not always know that homogeneous mixtures are mixtures because you can't tell by looking. Which mixtures in **Figure 26** are homogeneous? No matter how closely you look, you can't see the individual parts that make up air or the parts of the mixture called brass in the lamp shown. Homogeneous mixtures can be solids, liquids, or gases.

A heterogeneous mixture has larger parts that are different from each other. You can see the different parts of a heterogeneous mixture, such as sand and water. How many heterogeneous mixtures are in the figure? A pepperoni and mushroom pizza is a tasty kind of heterogeneous mixture. Other examples of this kind of mixture include tacos, vegetable soup, a toy box full of toys, or a tool box full of nuts and bolts.

Earth Science
INTEGRATION

Scientists called geologists study rocks and minerals. A mineral is composed of a pure substance. Rocks are mixtures and can be described as being homogeneous or heterogeneous. Research to learn more about rocks and minerals and note some examples of homogeneous and heterogeneous rocks in your Science Journal.

Section 3 Assessment

1. List three examples of compounds and three examples of mixtures. Explain your choices.
2. How can you tell that a substance is a compound by looking at its formula?
3. Which kind of mixture is sometimes difficult to distinguish from a compound? Why?
4. What is the difference between homogeneous and heterogeneous mixtures?
5. **Think Critically** Was your breakfast a compound, a homogeneous mixture, or a heterogeneous mixture? Explain.

Skill Builder Activities

6. **Comparing and Contrasting** Compare and contrast compounds and mixtures based on what you have learned from this section. **For more help, refer to the Science Skill Handbook.**
7. **Using a Database** Use a computerized card catalog or database to find out about one element from the periodic table. Include information about the properties and uses of the mixtures and/or compounds the element is found in. **For more help, refer to the Technology Skill Handbook.**