6.2 Elements and Compounds

LEARNING TIP

The key vocabulary words on the next two pages are illustrated with both photographs and drawings that show you the particles. If you are having trouble remembering the difference between elements and compounds, use the illustrations for clarification.

There are millions of pure substances. Can anyone expect to learn about all of them? How would you start? How would you find out which ones are safe? How would you find out which ones are useful?

People have investigated pure substances for thousands of years. Ten thousand years ago, people learned how to extract copper from rocks by heating the ore. In medieval times, alchemists [AL-ku-mists] tried to break down metals, such as copper, to make gold. They dissolved and mixed various substances, filtered, and heated. None of the alchemists ever succeeded in making gold. They discovered, however, that some pure substances can be broken down into other pure substances, while others cannot. For this reason, pure substances are classified into two types: elements and compounds.

Elements

Elements are pure substances that cannot be broken down into any other pure substances. After many investigations, scientists found that there are only about 104 pure substances that are elements.

Elements are composed of only one kind of particle. For instance, aluminum foil is made of the element aluminum. It is composed of only particles of aluminum (**Figure 1**).

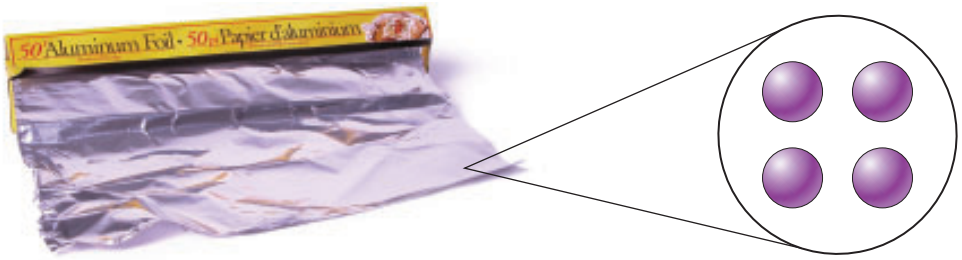


Figure 1
The element aluminum in aluminum foil is composed of aluminum particles.

Some elements, such as iron, aluminum, and oxygen, are common in nature, although they are usually found mixed with other substances. Other elements, such as krypton, are extremely rare. Some elements are considered safe. Other elements, such as sodium and chlorine, are explosive or poisonous.

Compounds

Elements can combine with other elements to form new pure substances, called compounds. **Compounds** are pure substances that are made up of two or more different elements. Compounds are related to elements in the same way that words are related to the letters of the alphabet. Thousands of words can be made from the 26 letters of the English alphabet. Similarly, millions of compounds can be made by combining the 104 elements.

Compounds can be solids, liquids, or gases. One example of a compound is water. Water is made up of the elements hydrogen and oxygen (**Figure 2**). Thus, a particle of water contains both hydrogen and oxygen. Every particle of water is the same as every other particle of water. At one time, scientists thought that water was made up of particles that could not be broken down further. Scientists now know, however, that water can be broken down into hydrogen and oxygen.

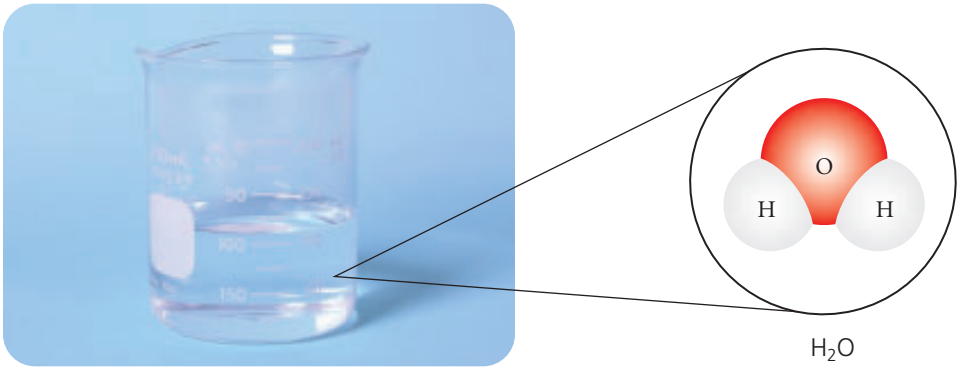


Figure 2
Water is a compound composed of hydrogen and oxygen particles.

The elements in some common compounds are listed in **Table 1**.

Table 1 Elements in Some Common Compounds

Compound	Elements combined in compound
water	hydrogen and oxygen
table salt (sodium chloride)	sodium and chlorine
carbon dioxide	carbon and oxygen
sugar (any type)	carbon, hydrogen, and oxygen
alcohol (any type)	carbon, hydrogen, and oxygen
chalk (calcium carbonate)	calcium, carbon, and oxygen
baking soda	sodium, hydrogen, carbon, and oxygen

Different elements have different properties because they have different particles. In the same way, different compounds have different properties because they have different combinations of elements. The properties of a compound can be very different from the properties of the elements that make it up. Table salt (**Figure 3**) is made of two elements, called sodium and chlorine. Sodium on its own is a soft, silvery metal that is poisonous and reacts violently with water (**Figure 4**). Chlorine is a greenish-yellow gas that is extremely poisonous (**Figure 5**). Each of these elements could be fatal if consumed on its own—for example, if you breathed in too much chlorine or swallowed a large quantity of sodium. When sodium and chlorine combine, however, they form table salt (sodium chloride), which you can safely eat and need in your diet.

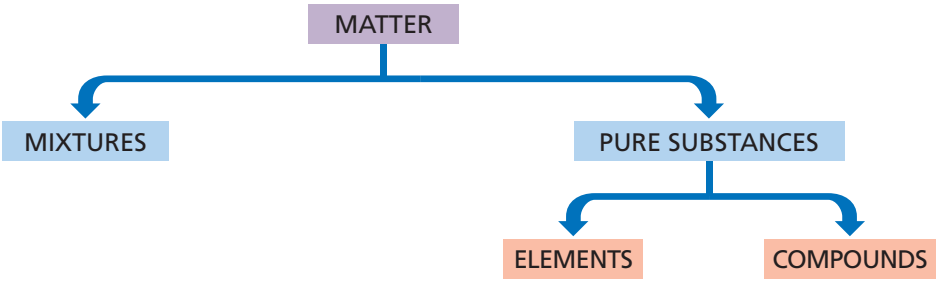
Figure 3
Table salt

Figure 4
Sodium metal

Figure 5
Chlorine gas

LEARNING TIP

Go back to the graphic organizer you started in section 6.1. Add "elements" and "compounds" under "pure substances." Your graphic organizer should now look like this:



TRY THIS: CLASSIFY MODELS OF MATTER

Skills Focus: creating models, classifying

Copy your graphic organizer onto a large piece of paper.
Your teacher will give you eight jars, containing the following items (**Figure 6**):

1. five nuts
2. five bolts, five nuts, and five washers
3. five bolts with nuts attached
4. five bolts with a nut attached and five bolts with a washer and a nut attached
5. five bolts
6. five nuts and five washers
7. five bolts with a washer and a nut attached
8. five washers

Figure 6

Each jar is a model, representing a different type of matter. Each bolt, nut, and washer represents a different type of particle. Classify the eight models of matter as elements, compounds, or mixtures by placing them in the appropriate places on your graphic organizer.

LEARNING TIP

If you are having difficulty remembering the differences between mixtures, pure substances, elements, and compounds, scan the text for the information you need and make notes on your graphic organizer before you try to classify the models.

CHECK YOUR UNDERSTANDING

1. Explain the difference between an element and a compound, using examples of each.
2. Explain the difference between an element and a compound, using the particle model.
3. State whether each pure substance is an element or a compound. Explain your reasoning.
   a) a clear, colourless liquid that can be split into two gases with different properties
   b) a yellow solid that always has the same properties and cannot be broken down
   c) a colourless gas that burns to produce carbon dioxide and water