Chapter 1 • Lesson 3

Objective: 8.P.1.1

Molecules, Compounds, and Crystals

Key Words • molecule • compound • chemical formula • subscript • crystal

Getting the Idea

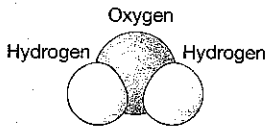
You have learned that atoms are the basic building blocks of almost all the matter around you. Each type of atom makes up a different element. Scientists have discovered only 118 elements. Yet there are far more than 118 different kinds of matter. This is because of the ways elements can combine to form new substances.

Molecules

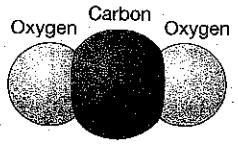
Two or more atoms can combine to form a molecule. A **molecule** is a group of two or more atoms held together by forces called chemical bonds. These bonds form between atoms that share or transfer electrons. You will learn more about chemical bonds in Lesson 5.

A molecule may contain atoms of only one element. Oxygen gas is a molecule made up of two oxygen atoms. Molecules can also form when two or more different elements join together. Look at the diagrams below. A water molecule contains two hydrogen atoms and one oxygen atom. A molecule of carbon dioxide contains one carbon atom and two oxygen atoms.

Water Molecule



Carbon Dioxide Molecule



Compounds

A **compound** is a substance that forms when two or more elements join chemically. Like elements, compounds are pure substances. The elements that make up a compound are always found in the same proportions. For example, every molecule of water is made of one oxygen atom and two hydrogen atoms. The elements in a compound cannot be separated by physical means. They can be separated only by chemical means.

A compound has different properties from those of the elements that make it up. Water is a compound made up of hydrogen and oxygen. Water is a liquid at room temperature, even though both hydrogen and oxygen are gases. Water is not flammable. This means it will not burn, even though hydrogen is flammable and oxygen allows it to burn. Table salt is made of the elements sodium and chlorine. Salt is a solid at room temperature and dissolves in water. In contrast, pure sodium is a very reactive metal that can explode when exposed to water. Chlorine is a poisonous, greenish gas at room temperature.

Naming and Identifying Compounds

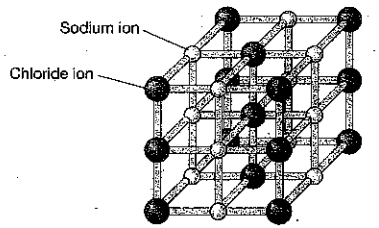
Most compounds are named for the elements they are made of. For example, carbon dioxide is named for carbon and oxygen. The prefix *di-* tells you that there are two atoms of oxygen in this compound. If you look back at the periodic table on page 15, you will see that carbon is to the left of oxygen. Usually, the element to the left appears first in the name of the compound.

Compounds can also be identified by chemical formulas. A **chemical formula** is a group of chemical symbols and numbers that shows the number of atoms of each element in a molecule. The formula for carbon dioxide is CO_2. C is the chemical symbol for carbon. O is the chemical symbol for oxygen. The number 2 in the formula is called a **subscript**. It shows that the molecule contains two atoms of oxygen. The C has no subscript. That means that the molecule contains only one atom of carbon.

Crystals

A **crystal** is a solid made up of particles that are arranged in a regular, repeating pattern. These particles can be atoms, molecules, or ions. Recall from Lesson 1 that an ion is a charged atom. In table salt, sodium and chloride ions alternate to form a repeating cube-shaped pattern. Other crystals display different patterns.

Crystal Structure of Table Salt



North Carolina's state stone is the emerald. Emeralds are made up of several elements including beryllium, aluminum, silicon, and oxygen. In an emerald, these elements form crystals with a repeating six-sided, or hexagonal, pattern.

Objective: 8.P.1.1

Mixtures

Key Words • mixture • heterogeneous mixture • homogeneous mixture • solution • solvent • solute • sifting • filtration • evaporation • hypothesis

Getting the Idea

A salad may contain things such as lettuce, celery, carrots, and other vegetables. You can see the different parts of the salad—even when they are jumbled together on your plate. This is because each of the different substances keeps its original properties. In this lesson, you will learn about the different ways substances can be mixed together. You will also learn how the substances can be separated.

Understanding Mixtures

You have learned that elements and compounds are pure substances. Sometimes pure substances mix together. A **mixture** is matter made up of two or more substances that are combined physically. The substances in a mixture do not change or combine chemically. They keep their own properties. For example, if you mix salt and sugar together, some of the crystals will still taste sweet, and some will taste salty.

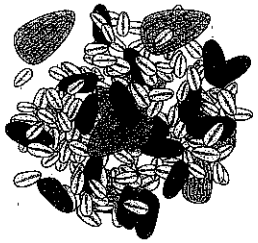
Recall that the makeup of any compound is always the same. In any molecule of the compound, the elements are always found in the same proportions. The makeup of a mixture can vary. A mixture of salt and sugar can contain more salt than sugar or more sugar than salt.

Mixtures can exist in all states of matter. Air is a mixture of gases. Alcohol and water is a mixture of two liquids. Sugar dissolves in water, making a mixture of a solid and a liquid. Steel is a mixture of two solids, iron and carbon.

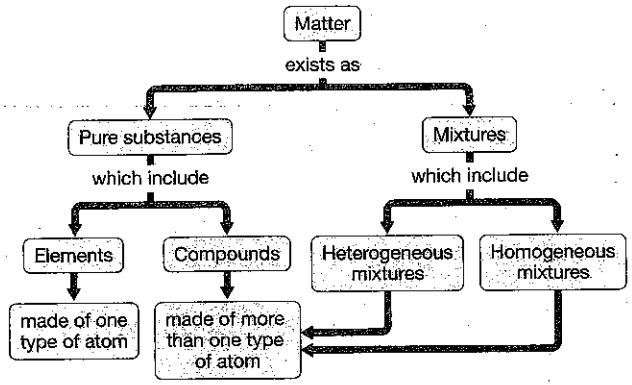
Classifying Mixtures

Mixtures can be classified into two groups: heterogeneous mixtures and homogeneous mixtures. In a **heterogeneous mixture**, substances are not distributed evenly throughout the mixture. The individual substances in a heterogeneous mixture are easy to distinguish.

A cereal such as granola is an example of a heterogeneous mixture. Each item keeps its consistency and flavor. If you divided the drawing below into fourths, you would see that the distribution of items is not even. Some parts of the sample have more almonds than other parts.



In a **homogeneous mixture**, substances are evenly distributed throughout the mixture. You cannot visibly distinguish the different parts of a homogeneous mixture from one another. The mixture has the same physical properties throughout.



Solutions

A **solution** is a homogeneous mixture in which one substance is completely dissolved in another substance. An example is sugar dissolved in water. Solutions are usually liquids. Solutions have two parts, the **solvent** and the **solute**. In a solution of sugar and water, water is the solvent and sugar is the solute. The solvent is the substance that does the dissolving. The solute is the substance that dissolves.

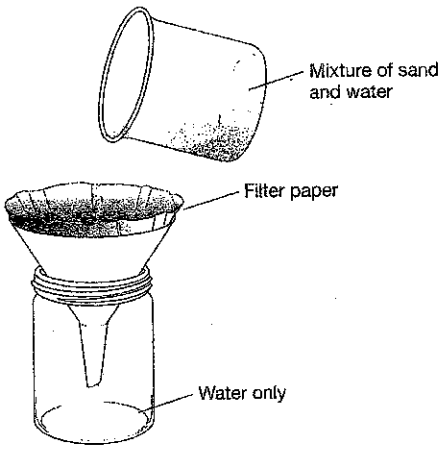
When sugar dissolves in water, water molecules are close enough to touch and slide past each other. The sugar molecules sit in the tiny spaces between water molecules. They remain evenly distributed throughout the water. However, the sugar and water are not chemically bonded.

Separating Mixtures

Unlike compounds, mixtures can be separated by physical means. The substances in a mixture have different properties that can be used to separate them. Methods used to separate mixtures include sifting, filtration, evaporation, and others.

Sifting separates the solid parts of a mixture by particle size. A screen or similar device is often used to sift materials. If you pour a mixture of sand and pebbles onto a screen, the small particles of sand will pass through the screen. The larger particles, the pebbles, will not.

Filtration separates a solid from a liquid in a heterogeneous mixture. Sand does not dissolve in water. If you pour a mixture of sand and water onto filter paper, the water will pass through the paper, but the sand will not.



Evaporation can be used to separate a solid from a liquid in a solution. Sugar dissolves when it is mixed with water, forming a solution. To separate the sugar from the water, the solution can be placed in a container and heated. As the water evaporates, or changes from a liquid to a gas, the sugar is left behind.

Reading questions

1. An element is made of what?
2. Define a molecule
3. Define compound
4. What does it mean to be a pure substance
5. what does it mean when the author states that compounds have different properties from elements that make it up. (explain this, DO NOT just write the example)
6. What is a mixture and what does it mean when we say they keep their own properties?
7. What is the difference between a heterogeneous and homogeneous mixture
8. What type of solutions forms mixtures?
9. Explain the 3 ways used to separate mixtures?