

Substances, Mixtures, and Solubility

section 1 What is a solution?

Before You Read

Do you add sugar to your tea? How do you know that the white substance will make your drink sweeter?

What You'll Learn

- the differences between substances and mixtures
- two types of mixtures
- how solutions form
- different types of solutions

Read to Learn

Substances

Water, salt water, and pulpy orange juice are different liquids. Their differences can be explained by chemistry. Think about pure water. If you freeze it, melt it, or boil it, it is still water. But, if you boil salt water, the water turns to gas and leaves the salt behind. If you strain pulpy orange juice, it loses its pulp. How does chemistry explain these differences? The answer has to do with the chemical makeup of these materials.

What are atoms, substances, and elements?

Atoms Recall that atoms are the basic building block of matter. Each atom has its own chemical and physical properties. These properties are determined by the number of protons the atom has.

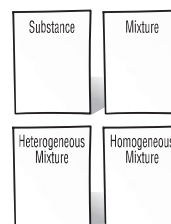
Substances A substance is matter that has the same fixed makeup and properties throughout. A substance cannot be broken down into simpler parts by a physical process. For example, you can freeze, boil, stir, and filter water, but it is still water. The only way to change a substance is by a chemical process. The table on the next page shows some examples of physical processes and chemical processes.

Mark the Text

Underline As you read, underline words and sentences that you think are important to remember. After you read, review what you have underlined.

FOLDABLES™

A Classify Use quarter-sheets of paper to help you organize definitions and examples of substances and mixtures.



Picture This

1. **Explain** How do physical processes differ from chemical processes?



Think it Over

2. **Classify** Why is water a compound and not an element?

Examples of Physical and Chemical Processes

Physical Processes (do not change substances)	Chemical Processes (do change substances)
Boiling	Burning
Changing pressure	Reacting with other chemicals
Cooling	Reacting with light
Sorting	

Elements An element is an example of a pure substance. An element cannot be broken down into simpler substances. The number of protons in an element cannot change unless the element changes.

What are compounds?

Water is a compound. A compound is a substance made of two or more elements that are chemically combined. The makeup of a compound is always the same. For example, a water molecule always has two hydrogen atoms combined with one oxygen atom. All water, whether frozen, liquid, or vapor, has the same ratio of hydrogen atoms to oxygen atoms.

Mixtures

Imagine drinking a glass of salt water. You would know right away that it is not pure water. Salt water is not a pure substance. It is a mixture of salt and water. Mixtures are made when two or more substances come together but do not chemically bond together to make a new substance. The substances can be separated by physical processes. For example, you can boil salt water to separate the salt from the water.

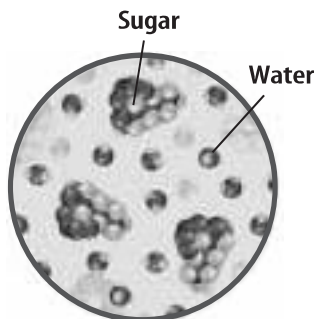
Mixtures do not contain an exact amount of each substance like a compound. Lemonade can be weak tasting or strong tasting. It depends on how much lemon juice is added to the water. It also can be sweet or sour, depending on how much sugar is added. No matter how strong, weak, sweet, or sour, it is still lemonade.

What are heterogeneous mixtures?

Some mixtures are easy to see. A watermelon is a mixture of fruit and seeds. But, the fruit and seeds aren't mixed evenly. A **heterogeneous** (he tuh ruh JEE nee us) **mixture** is a mixture where the substances are not mixed evenly. The substances in heterogeneous mixtures are usually easy to tell apart. A bowl of cereal with milk is another example of a heterogeneous mixture.

What are homogeneous mixtures?

When you mix sugar and water together you don't see the sugar particles floating in the water. Sugar water is a homogeneous (ho muh JEE nee us) mixture. A **homogeneous mixture** has two or more substances in which the molecules mix evenly but do not bond together. Another name for a homogeneous mixture is a **solution**. The figure shows the mixture of sugar and water molecules in a solution of sugar water.



How Solutions Form

When you mix sugar and water together, you can't see the sugar particles in the water. The sugar doesn't actually disappear. The sugar molecules spread out until they are evenly spaced throughout the water molecules, forming a solution. This is called dissolving. The substance in a solution that dissolves, or seems to disappear, is called the **solute**. The substance that dissolves the solute in a solution is the **solvent**. In the sugar water solution, the sugar is the solute and water is the solvent.

How can solids form from solutions?

Sometimes, a solute can come back out of a solution and form a solid. This process is called crystallization.

Crystallization Crystallization happens because of a physical change. For example, crystallization can happen when a solution is cooled. Crystallization also can happen when some of the solvent evaporates. A stalactite, or hanging rock, in a cave is an example of crystallization. Minerals dissolve in water as it flows through rocks. When the solution drips from the ceiling of the cave, some of the water evaporates. The minerals in the solution crystallize to form the stalactite.

Picture This

3. Describe Look at the figure. How would you describe the sugar and water molecules in a solution of sugar water? Circle the answer.

- a. not mixed evenly
- b. combined
- c. mixed evenly
- d. compounded



Think it Over

4. Apply Minerals dissolve in water as it flows through rocks at the top of the cave. In this solution, what is the solute and what is the solvent?

Precipitate Formation When some solutions are mixed, a chemical change happens and a solid forms. A solid that forms when solutions are mixed and a chemical change happens is a **precipitate** (prih SIH puh tut). Precipitate formation is different from crystallization because a chemical change takes place. A precipitate can form in a shower. Minerals that are dissolved in water can react chemically with soap. This chemical reaction forms a precipitate called soap scum.

Types of Solutions

Not all solutions are solid solutes dissolved in liquid solvents. Solutions can be made up of combinations of solids, liquids, and gases. See the examples in the table.

Examples of Common Solutions			
Solution	Solvent/ State	Solute/ State	State of Solution
Earth's atmosphere	nitrogen/gas	oxygen/gas carbon dioxide/gas argon/gas	gas
Carbonated beverage	water/liquid	carbon dioxide/gas	liquid
Brass	copper/solid	zinc/solid	solid

Liquid Solutions

Sugar water and salt water are examples of solutions with liquid solvents and solid solutes. The solute in a solution can be a solid, another liquid, or even a gas. The state of the solution will usually be the same as the state of the solvent. For example, sugar is a solid and water is a liquid. When sugar and water are mixed together to form a solution, the solution is a liquid, not a solid. ✓

What are liquid-gas and liquid-liquid solutions?

Liquid-Gas Carbonated drinks are examples of solutions with liquid solvents and gas solutes. The gas solute is carbon dioxide. Water is the liquid solvent. Carbon dioxide gives the drinks their fizz.

Picture This

5. Interpret Data Name two solutions that have carbon dioxide as one of the solutes.

✓ Reading Check

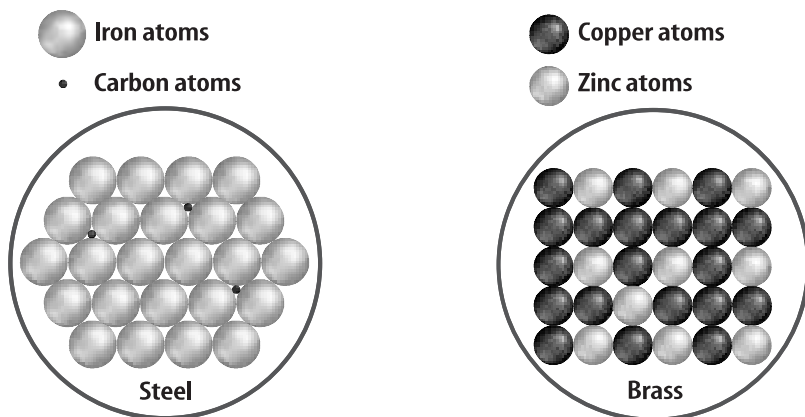
6. Explain What does the state of a solution usually depend on?

Liquid-Liquid Vinegar is an example of a liquid-liquid solution. Water is the liquid solvent and acetic acid is the liquid solute. In vinegar, only 5 percent of the solution is acetic acid. Water makes up 95 percent of the solution.

Gaseous and Solid Solutions

Gas Solutions Sometimes, a small amount of one gas is dissolved in a larger amount of another gas. This is a gaseous solution, also called a gas-gas solution. The air you breathe is a gaseous solution. About 78 percent of air is nitrogen, which is the solvent. About 20 percent of air is oxygen, which is one of the solutes. Other solutes in air are carbon dioxide, argon, and some other gases in small amounts.

Solid Solutions There are also solid solutions. In a solid solution, the solvent is solid. The solute can be a solid, liquid, or gas. The most common solid solutions are solid-solid solutions. Both the solvent and solute are solids. Steel is a solution of carbon dissolved in iron. A solid-solid solution made from two or more metals is called an alloy. Brass is an alloy of zinc dissolved in copper. The figure shows what microscopic views of steel and brass might look like. ✓



✓ Reading Check

7. Identify What states can the solutes be in a solid solution?

Applying Math

8. Interpret a Scientific Illustration Look at the sample of brass in the figure. What is the ratio of copper atoms to the total number of atoms?
