

section • How Solutions Form

What You'll Learn

- three types of solutions
- how things dissolve
- the rate solids and
- gases dissolve

Mark the Text

Locate Information As you read this section, highlight

you read this section, highlight the factors that affect how quickly substances dissolve.

FOLDABLES

A Draw and Label Make a half-sheet Foldable like the one below. As you read, draw three diagrams showing solute and solvent molecules before dissolving, during dissolving, and after dissolving. Label your drawings.



Before You Read

Have you ever made a drink from a powdered mix? What happened to the powder?

Read to Learn

What is a solution?

Many people like to watch hummingbirds and put up hummingbird feeders in their yards. They fill the feeders with a red liquid made of water, sugar, and red food coloring. The sweet, colored liquid attracts hummingbirds. To make this food, you add sugar to water and stir. When you stir, the sugar crystals disappear. Next, you add a few drops of red food coloring and stir again. The red color spreads evenly. Why does this happen?

The red sugar-water is a solution. A <u>solution</u> is mixture that has the same ingredients, color, density, and even taste mixed evenly throughout. You cannot see the sugar crystals in the solution because they have broken up into molecules. The

food coloring also breaks up into molecules. The sugar molecules and the food coloring molecules mix evenly among the water molecules throughout the solution. The figure shows what a sugar-water solution would look like if you could see the separate molecules.



Liquid Solution

Solutes and Solvents

To describe a solution, you could say that one substance dissolves in another. In a solution, the <u>solute</u> is the substance that dissolves. The <u>solvent</u> is the substance that is doing the dissolving. In sugar-water, the sugar is the solute and the water is the solvent.

What can dissolve in a liquid?

In a solution made with a liquid and a solid, the solid is the solute and the liquid is the solvent. In salt water, salt is the solute and water is the solvent.

Some solutions are made from a gas dissolved in a liquid. In carbonated soda, carbon dioxide gas is dissolved in water. The gas is the solute and the liquid is the solvent.

Other solutions have a liquid dissolved in another liquid, such as the liquid food coloring in the hummingbird food. The solvent is usually the liquid present in the larger amount.

Are there solutions that do not contain a liquid?

Solutions also can be mixtures of gases or even mixtures of solids. The air you breathe is a solution. Air is a solution of 78 percent nitrogen, 20 percent oxygen, and small amounts of other gases. Look at the figures below. The figure on the left shows different gas molecules in a gas solution.

Some jewelry is made of mixtures of metals. Sterling silver is a mixture of silver and copper. Mixtures of metals are solid solutions. In a solid solution, one metal is the solute and the other metal is the solvent. The two metals are melted together. Solid solutions are known as alloys. An <u>alloy</u> is a mixture of elements that have metallic properties. Some musical instruments are made of an alloy called brass. Brass is a solid solution of copper and tin. The figure on the right shows atoms of copper and tin in a solid solution brass. Coins are alloys.



How Substances Dissolve

Fruit drinks and sports drinks are examples of solutions made by dissolving solids in liquids. Both contain sugar and other substances that add color and flavor to the drink. You know that sugar dissolves in water, but how does it happen?

A solid starts to dissolve at its surface. To understand how a water solution forms, you need to remember two things you have learned about water molecules. First, water molecules, like all particles, are always moving. Second, water molecules are polar. Polar means that they have a positive end and a negative end. Sugar molecules are also polar.

Picture This

1. **Observe** Look at the spacing of the atoms in the two solutions on this page and the liquid solution on the first page. Which is denser, a solid solution, a gaseous solution, or a liquid solution?



2. Explain Where does a solid start to dissolve?

Picture This

3. Identify Circle a water molecule in the first figure. Mark the positive ends with a plus sign and the negative end with a minus sign.

How does a solid dissolve in a liquid?

The figures below show how sugar dissolves in water. In the figure on the left, water molecules move toward a sugar crystal. The positive ends of sugar molecules attract the negative ends of water molecules.

In the middle figure, water molecules pull sugar molecules into solution. This process continues as layer after layer of sugar molecules move away from the crystal. Finally, the crystal dissolves completely.

The water molecules and sugar molecules spread out and mix evenly. They are now a homogeneous solution. The figure on the right shows sugar molecules surrounded by water molecules in a sugar-water solution. This process happens whenever a liquid solvent dissolves a solid solute.





4. Explain what must be done to solids so they can be mixed together.

How do liquid and gas solutions form?

Liquids and gases also can form solutions. Liquid and gas particles form solutions in a way similar to that of sugar and water. But, the process is more complex. Liquid particles and gas particles move much faster than solid particles. The movement separates the solute particles and mixes them evenly in the solvent. The result is a homogeneous solution.

How do solids dissolve in other solids?

You have learned that all particles move. Particles in a solid do not move enough to spread out and mix evenly with other solids. Solids must be melted into liquids and then mixed together. In the liquid state, the atoms can move more freely. They spread out and form a homogeneous solution. The atoms stay in solution after cooling.

Rate of Dissolving

Sometimes a solute dissolves quickly into a solvent. At other times, it dissolves more slowly. There are some things you can do to make a solute dissolve faster. You can stir the solution or heat the solution. If the solute is a solid, you can break it into smaller pieces.

How does stirring speed up dissolving?

Stirring a solution speeds up the dissolving process by making the solvent and solute particles move faster. More solvent particles come into contact with more solute particles. The solid solute dissolves more quickly.

How does breaking up a solid solute speed up dissolving?

Suppose you put a piece of rock candy in your drink to sweeten it. You may have to wait a long time for the candy to dissolve. Now, suppose you crush the rock candy into a powder before adding it to your drink. The small pieces of candy dissolve much more quickly than the chunk of candy. Why?

When you break a solid solute into smaller pieces, you increase its surface area. Remember that the dissolving process takes place at the surface of the solute. More surface area means that more solute comes in contact with the solvent. When the surface area of the solute increases, the solute dissolves more quickly.

How does heating speed up dissolving?

When you make hot chocolate from a mix, you mix the powder into a hot liquid. The sugar in the mix dissolves faster in a hot liquid solvent. Solvent particles move faster when the temperature of the solvent increases. Fast-moving solvent particles have more chances to come in contact with solute particles. The more often they come in contact, the faster the solute particles break loose and dissolve.

Can you combine these methods?

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If you use more than one of these methods at the same time, you can speed up the dissolving process even more. Suppose you place a sugar cube in cold water. You know the sugar will dissolve eventually. If you heat the water, the sugar will dissolve at a faster rate. If you heat the water and stir the solution, you increase that rate even more. Finally, if you crush the sugar cube, heat the water, and stir the solution, the sugar will dissolve at the fastest rate. The rate of dissolving increases with each additional method you use.



5. Determine Why does breaking up a solid solute into smaller pieces speed up the dissolving process?



6. Infer What do both stirring and heating do that increases the rate that particles dissolve?

After You Read

Mini Glossary

alloy: a mixture of elements with metallic properties **solute:** the substance that is dissolved in a solution

solvent: the substance that does the dissolving in a solution

1. Review the terms and definitions in the Mini Glossary. Select one term and write a definition of the term in your own words.

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2. Complete the outline to help you organize what you learned about solutions.

| I. | Solutions |
|------|---|
| | A. A solution is |
| | B. An example of a solution made with a liquid and a solid is |
| | C. An example of a solution made with a liquid and a gas is |
| | D. An example of a solution made with two solids is |
| II. | Solutes and solvents |
| | A. A solute is |
| | B. A solvent is |
| III. | . How substances dissolve |
| | A. Water molecules approach the solid solute. |
| | B |
| | С |
| IV. | Rate of dissolving is affected by |
| | A |
| | B |
| | C |
| | |