LEARN ABOUT

How Water Interacts with Other Matter

FIND OUT

- how solids dissolve in water
- why objects float or sink

VOCABULARY

solution
dissolve
solubility
buoyancy

Water and Sugar

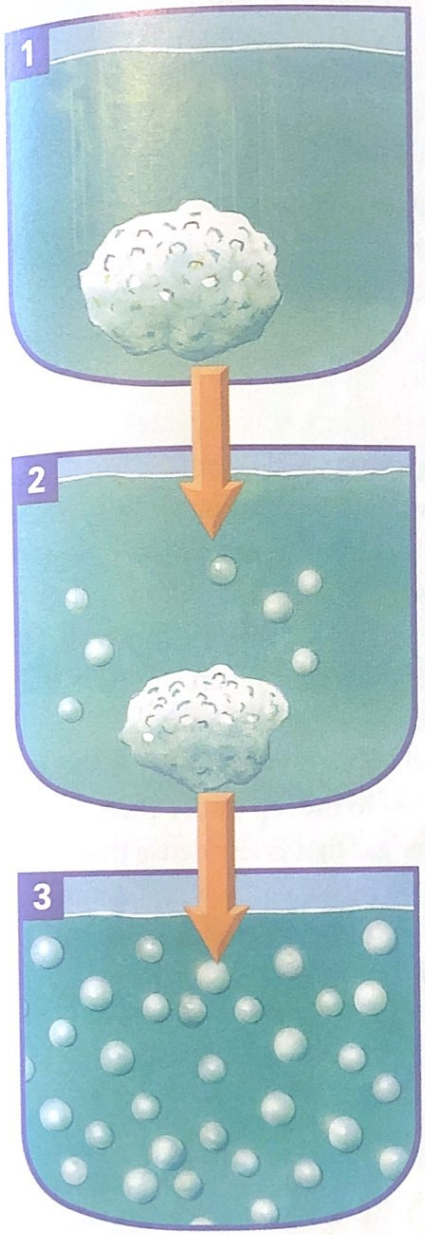
If you put a spoonful of solid sugar into a glass of liquid water and stir, what happens? The sugar seems to disappear. The glass still contains a clear liquid. Where did the sugar go?

The answer is that the sugar and the water formed a kind of mixture called a solution. A **solution** (suh•LOO•shuhn) is a mixture in which the atoms and molecules of different kinds of matter are mixed evenly with each other. In this case the sugar molecules mixed with the water molecules. You can't see the sugar, but you can tell it is there because the solution tastes sweet. Another way to show that the sugar is still there is to let the water evaporate, or dry up. After all the water is gone, solid sugar will be left at the bottom of the glass.

When you mix sugar and water, they form a solution. What is happening to the sugar as you stir the water? ▼

Dissolving

1. When a lump of sugar dissolves in water, water molecules pull sugar molecules away from the solid sugar.
2. Moving water molecules spread sugar molecules to all parts of the solution.
3. After a while all the sugar molecules are pulled away by water molecules. The sugar is completely dissolved. It can't be seen because the molecules are too small and spread out.



When one material forms a solution with another material, we say it **dissolves** (dih•ZAHLVZ). As sugar dissolves in water, molecules of solid sugar are pulled away from each other by water molecules. The water molecules bump into and move the sugar. Very quickly the sugar molecules spread to all parts of the solution. You can no longer see the sugar because the very small sugar molecules are mixed evenly with the water molecules.

If you add more and more sugar to a glass of water, at some point the sugar molecules can't mix evenly with the water molecules. The extra sugar doesn't dissolve. When you stop stirring, the extra sugar falls to the bottom of the glass.

Some solids dissolve in water. Other solids do not. Try stirring sand into water. While you are stirring, the sand mixes with the water but does not dissolve. When you stop stirring, the sand falls to the bottom of the jar. **Solubility** (sahl•yoo•BIL•uh•tee) is a measure of the amount of a material that will dissolve in another material. The solubility of sand in water is zero. No amount of sand dissolves in water.

✓ **What happens to a solid when it forms a solution with water?**

Solubility in Water

Material	Volume of Water (mL)	Mass of Material That Can Be Dissolved in Water at 25°C (g)
Sugar	100	105
Salt	100	36
Baking soda	100	7
Sand	100	0

Floating and Sinking

If you put a coin, such as a penny, into water, it doesn't dissolve. It sinks. A chip of wood doesn't dissolve in water, either. It floats. The ability of matter to float in a liquid or gas is called **buoyancy** (BOY•uhn•see).

A solid object denser than water sinks in water. Lead is more than 11 times as dense as water, so a lead fishing weight rapidly sinks. A solid object less dense than water floats in water. Pine wood is about half as dense as water. So a plank of pine floats.

▲ Most humans have a density that is a little less than 1 gram per cubic centimeter, so they float in water.

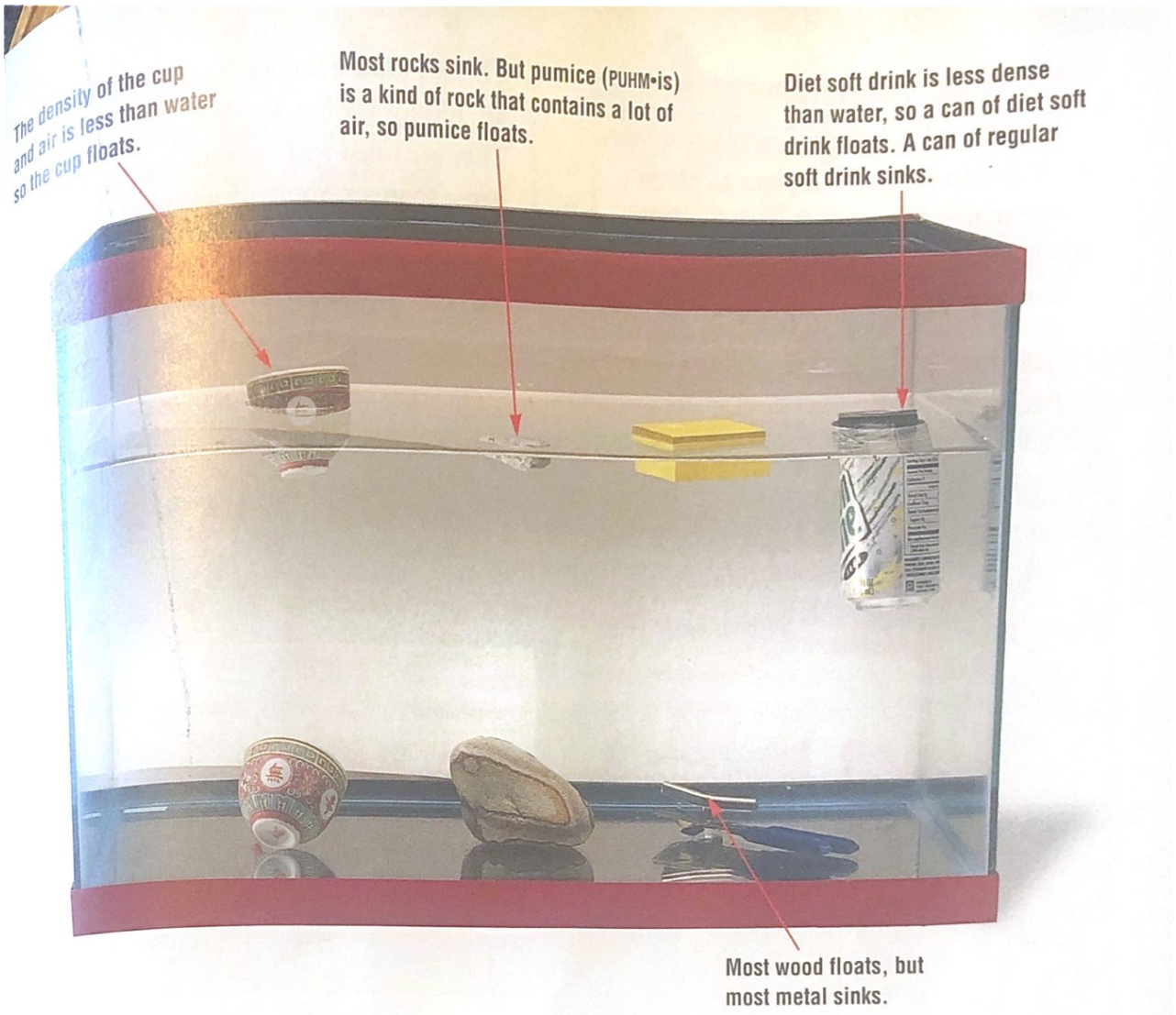
If you tied several pine planks together to form a raft, the raft would float because it is made of a material that is less dense than water.

Liquids can also float or sink. Have you ever seen rainbow streaks on puddles on a road or sidewalk? Motor oil floating on the water causes the streaks. The oil floats because it is less dense than water.

Some liquids sink in water. Maple syrup is mostly a sugar solution. It is denser than pure water. Maple syrup sinks to the bottom when you pour it into a glass of water.

Gases can also sink or float. All the gases in the air you breathe are much less dense than liquid water. When you blow through a drinking straw into water, air bubbles are pushed up, or buoyed up, by the water. They rise to the top of the glass. Helium is another gas that is less dense than air. When you fill a balloon with helium, it is buoyed up by the air and rises.

◀ A scuba diver wears a belt or vest with dense pieces of lead. This makes the diver's density about the same as that of water. With the belt on, the diver can swim up or down easily.



Remember from Lesson 2 that you can change the density of a material by mixing it with material that has a different density.

Air is not very dense. A good way to lower the density of an object is to add air to it. If you add enough air, the object will become less dense than water. Then it will float. Clay is denser than water. In the investigation you got clay to float by making it into a boat. A boat contains air. The sides and bottom of a boat keep water out and hold air in. The clay boat floated because it contained a lot of air. Even a heavy metal boat will float if it contains enough air.

Most human bodies are a little less dense than water. So, most people float on water. Scuba divers don't want to float or sink. If they floated, they would have to swim hard to stay under water. If they sank, they would have to swim hard to get back to the water's surface. Scuba divers control their buoyancy by wearing a belt or vest loaded with dense lead pieces. While wearing the lead weights, a diver has about the same density as water.

✓ What is buoyancy?

Each liquid layer in this beaker has a different density. The densest layer is liquid mercury on the bottom. Even a steel bolt floats on mercury. The less dense materials float on the more dense materials. ►

Floating Transportation

Humans use machines to control buoyancy and to move from place to place. Submarines, hot-air balloons, and blimps all use buoyancy to help move people. Hot-air balloons are buoyed up by air, so they rise. This is because hot air is less dense than cool air. Blimps are big, football-shaped balloons. They are filled with helium, a gas that is less dense than air. Submarines control their density to float and to sink in the water.

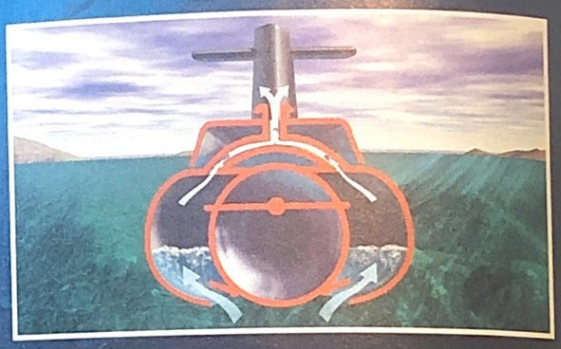
✓ **How is buoyancy used for travel?**

THE INSIDE STORY

How Submarines Work

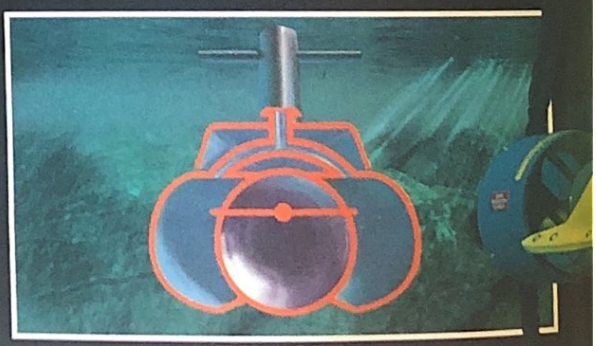
Submarines can float on top of the ocean or dive down and travel deep under water. They do this by adding or removing water to control their density.

1. When a submarine floats on the surface of the water, it is like any other metal boat. It is filled with enough air to make it float.



2. Tanks inside the submarine have air in them when the submarine is at the surface. To make the submarine float just below the surface, some of the air is taken out and the tanks are partly filled with water. The combination of the submarine, the water, and the air has about the same density as water.

3. The submarine can dive to the bottom by squeezing air in its tanks into smaller tanks. Because the air's volume is now smaller, its density is greater. The original tanks are then filled with water. This makes the metal submarine denser than water. To allow the submarine to return to the surface, water is pumped out of the tanks. Air is allowed to expand back into them. The submarine becomes less dense than water. It is buoyed up and rises to the surface.



Summary

Solutions are mixtures in which the atoms and molecules are mixed evenly. Some matter dissolves in water and some does not. Matter that is less dense than water floats on water. Buoyancy can be controlled by changing density.

Review

1. What changes happen to sugar when it dissolves in water? What stays the same?
2. What happens when you add more of a material to water than the water will dissolve?
3. How can you float a piece of solid material that is denser than water?
4. **Critical Thinking** What could you do to make an object float in air?
5. **Test Prep** Any material that floats in water —
   - A is denser than water
   - B has the same density as water
   - C is less dense than water
   - D is made of metal

LINKS

MATH LINK

Solubility The greatest amount of sugar you can dissolve in 100 milliliters of water is 105 grams. How much sugar can you dissolve in 1000 milliliters of water?

WRITING LINK

Informative Writing—Explanation Find out what the ancient Greek scientist Archimedes discovered about density. Write an explanation of what you learn for a younger student.

PHYSICAL EDUCATION LINK

Floating and Swimming Find out what survival floating is. Use a model to demonstrate it for your class, or make a poster that explains it.

LITERATURE LINK

Submarine Predictions Read *20,000 Leagues Under the Sea* to find out what French science-fiction writer Jules Verne predicted about the modern submarine.

TECHNOLOGY LINK

Learn more about physical properties of matter by viewing *Peep Science* on the **Harcourt Science Newsroom Video** in your classroom video library.