Solids, Liquids, and Gases

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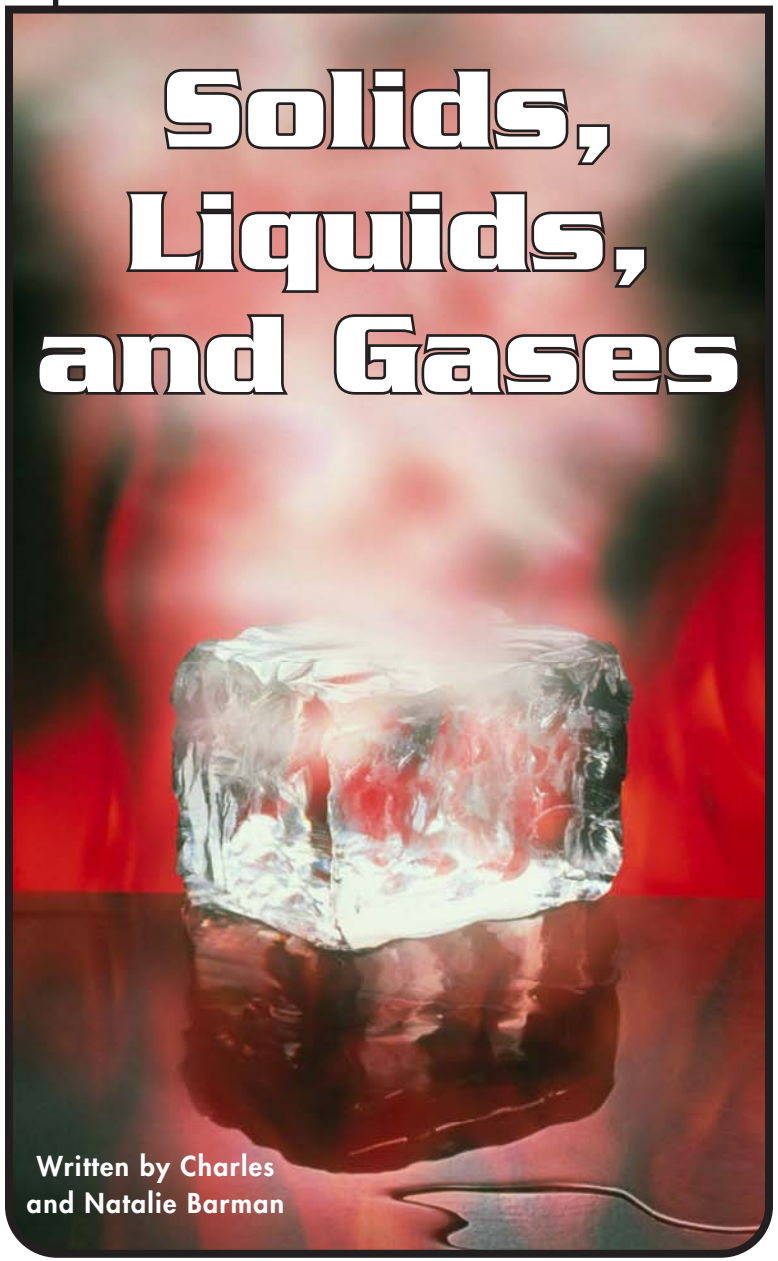

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Solids, Liquids, and Gases

Written by Charles and Natalie Barman

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KEY ELEMENTS USED IN THIS BOOK
The Big Idea: All things on Earth consist of matter. The most common states of matter are solids, liquids, and gases. Matter can change from one state to another. Matter in each state has identifiable properties. When matter combines, a mixture may form. The components of that mixture may retain their individual properties when combined, or the mixture may take on new properties. What allows us to have so many different things all around us is that matter can be found in various states, and it combines with other matter in many ways. It is useful to understand how materials may change when combined or when subjected to changes in temperature. This knowledge can keep us safe, and it has led to the development of medicines, fuels, recipes, and much, much more.
Key words: air, air pressure, condense, energy, evaporate, freeze, frozen, gas, heat, lava, liquid, magma, matter, melt, mixture, physical change, pressure, properties, sand, shape, size, solid, solution, states of matter, substance, surface, temperature, water, water vapor **Key comprehension skills:** Classify information *Other suitable comprehension skills:* Compare and contrast; cause and effect; main idea and details; identify facts; elements of a genre **Key reading strategy:** Summarize *Other suitable reading strategies:* Connect to prior knowledge; ask and answer questions; visualize; using a table of contents and headings; using a glossary and boldfaced terms

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Ice cream with whipped cream uses solid, frozen cream; liquid cream; and a gas in the can.

Introduction

Look around you. What do you see? Look at the book you are reading. Does it have a certain shape that you can describe? What about the air you breathe? Can you feel it, smell it, or taste it? What about water from a drinking fountain? Can you see it and feel it? Does it have a certain size or shape?

Your world is made of many objects and **substances**. Each has its own **properties**. These properties may include color, size, **temperature**, and a particular shape or lack of shape. An object might feel rough or smooth, soft or hard, wet or dry. What are some other properties you can use to describe a thing? In this book, you will learn about the objects and substances all around you as well as how these substances change.

How can you describe water from a fountain?

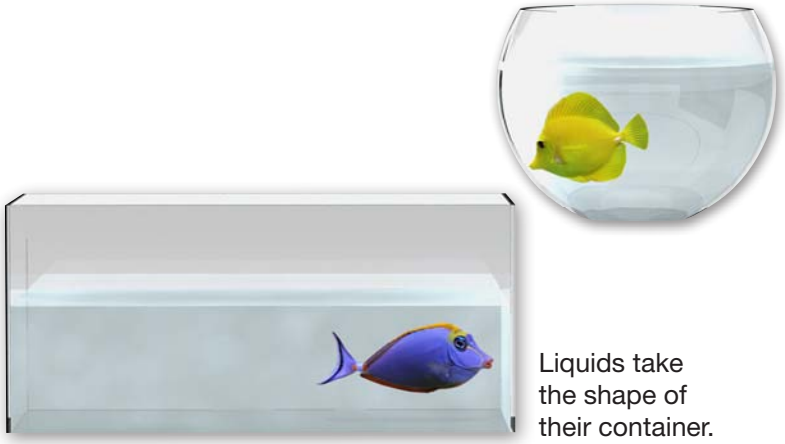
Matter

The things around you that take up space are known as **matter**. Your desk, the milk you drink, and the air inside a basketball are matter. They all take up space. A grain of sand is a small bit of matter that takes up a small amount of space. The water in a swimming pool takes up a lot of space. You are made of matter. If you are sitting in a chair, no one else can sit in that same space at the same time. No two things can occupy the same space at the same time. Before you pour a glass of milk, the glass is full of air. When you pour milk into the glass, the milk pushes the air out of the glass. As you drink the milk, air moves back into the glass.

Types of Matter

Matter comes in three main forms. These forms are called the **states of matter**. Let's look at the picture of a fish tank. You can see gravel at the bottom of the tank. You can also see fish, plants, and decorations. These things each have a specific shape. They also take up a specific amount of space. Matter that takes up a specific amount of space, has a specific shape, and keeps that shape when moved from place to place is called a **solid**. Even the tank is a solid. You can move it from one place to another without it changing shape. When the tank is moved, it takes up the same amount of space.

Which states of matter do you see?



Liquids take the shape of their container.

The water that the fish swim in does not keep the same shape when moved from one place to another. But if the water were moved into a different-shaped container of the same size, it would take up the same amount of space. For example, if the water in the tank were moved into a large, round bowl, it would take the shape of the bowl. If the water in the tank were moved to a bowl smaller than the tank, the water would spill over the top of the bowl. The water in the tank cannot be squeezed into a smaller space. If the bowl were bigger than the tank, the water from the tank would not expand to fill the bowl. Matter that does not keep the same shape when moved from place to place and cannot be squeezed into a smaller space is a **liquid**.

Objects can move through liquids, and liquids can move around objects. When a liquid is poured, it fills the container from the bottom. It also takes the shape of the container and forms a flat surface on top. Notice how the water fills the space inside the two fishbowls on the previous page. Even though the sides are different shapes, the top surface of the water in both is flat.

Do You Know?

Even though we can "pour" sand from one container to another, it is not a liquid. Why not? A pile of sand contains thousands of very small individual grains. Each small grain of sand is a solid. When you pour sand, it does take the shape of the container, just as liquid matter does. But each little solid grain of sand keeps its shape; it is the *position* of each tiny grain of sand that changes. The sand doesn't immediately settle and have a flat top.

Air in the water forms bubbles of gas.

You can see air bubbles floating up through the water in this fish tank. An air pump brings air from outside the tank into the water. You see the bubbles made by the air in the water, but you can't see the air in a classroom. Air is invisible. Although you cannot see air, you can feel it against your skin when the wind blows.

Air in the classroom and in the bubbles is an example of a state of matter called **gas**. Gas takes up space, just as liquids and solids do. The air bubbles in the fish tank are taking up space. You have probably also seen the evidence of air taking up space in balloons and bicycle tires. You can see a balloon get bigger as more air is blown into it. And a bicycle tire gets fatter and harder as air is pumped into it.

Gases are like liquids because they don't have a specific shape. Gases take the shape of the container they are in. The air inside a basketball, a football, and a tire all takes different shapes. But gases are also different from liquids. Unlike liquids, gases can be squeezed into a smaller space. When a tire is filled with more and more air, the air pushes harder against the inside of the tire and makes the tire harder. As more air is squeezed into a small space, the pressure inside the space increases. If you add too much air to a balloon, the pressure inside will build up until the balloon pops.

As you blow into a balloon, the gas squeezes so more air fits inside.

Do You Know?

Things like sound, heat, and electricity are not states of matter. They are forms of energy. Energy does not take up space, and you cannot weigh it.

Science In Your World

Things like tires, footballs, and basketballs work best when they have the right amount of air. If a tire does not have enough air pressure, it will be flat. If a basketball has too little pressure, it will not bounce. If it has too much pressure, it will explode. Look on the edge of a tire or near the place where you put air into a basketball. You will see a number that tells you the amount of pressure to put into the tire or ball.

PSI is a measure of pounds per square inch, or air pressure.

Changing Matter

Matter can change from one state to another. Have you ever made your own Popsicles by freezing a fruit drink in an ice cube tray? If you have, you changed a liquid into a solid by lowering the temperature. When you eat a Popsicle on a hot day, the Popsicle melts and drips down your fingers. Just by changing the temperature, you can change a liquid into a solid and a solid back into a liquid.

Adding heat can make a solid melt to a liquid.

Have you ever spilled a drink of water and forgotten to clean it up? When you look at where you spilled the water the next day, you can't see it. It changed into an invisible gas called **water vapor.** When liquid water changes to a gas, it **evaporates.** The change of a liquid to a gas is called *evaporation.* You don't need warm temperatures to make a liquid evaporate, but increasing the temperature will make it evaporate faster.

Think About It

The water droplets on the outside of the glass came from the air, not from the water inside the glass. Why did water condense on the glass?

Have you ever seen water droplets form on the outside of a glass of ice water? Where did this water come from? The water on the outside formed when water vapor in the air touched the cold glass. It did not come from inside the glass. The temperature of the water vapor cooled when it touched the cold glass, causing it to change to a liquid. When a gas changes to a liquid, it **condenses**. The change is called *condensation.*

Let's think about what happens with a fish tank in the classroom. If you never added new water to the fish tank, the water would evaporate. Over time, all the water would go into the air. So when you and your teacher are gone, it is a good idea to put a lid over the tank. Doing that will prevent the evaporated water from leaving the tank. Some of the evaporated water will condense on the lid and form little drops of water. When enough water condenses, it will form bigger drops that will fall back into the tank.

When substances change from one form to another, scientists say they change state.

Do You Know?

Earth's water is found in all three states. About two-thirds of Earth's surface is covered by liquid or solid water. The oceans, rivers, and lakes make up most of the liquid water. The ice caps of the North and South Poles make up most of the solid water. Some of Earth's water is a gas—water vapor—in the atmosphere.

What states of matter have been combined in this child's lunch?

Combining Matter

It may seem easy to identify different states of matter. In many cases, this is true. But it may not always be so easy. Let's think about lunch. Pretend that you are going to have chicken soup, crackers, a cheese sandwich, and a glass of lemonade.

You probably identified the crackers and cheese sandwich as solids. But what about the other food items? How would you describe the soup? The soup contains liquid. But it also has some solid pieces of chicken, vegetables, and noodles. Because the soup has two states of matter that can be separated, it is called a **mixture**.

Lemonade is another kind of mixture. It is made of lemon juice (liquid), water (liquid), and sugar (solid). This type of mixture is called a **solution**. Solutions are often a combination of liquids and solids.

Lemonade often has two liquids and at least one solid. What other solid might also be included?

WOWSER!

Inside Earth is liquid rock called *magma*. The rock is in a liquid state because of the great heat inside Earth. Cracks in Earth's crust allow the magma to reach Earth's surface. When it reaches the surface, it is called *lava*. When the lava cools, it becomes solid rock.

Left: Sand in a glass of water will settle to the bottom over time.
Right: Salt mixed with water remains a solution.

Let's look at another example of combining solids and liquids. Sometimes the mixture changes as time passes, and sometimes it does not. If you mix sand and water together in a jar and shake it, you simply get a mixture of sand and water. If you let the mixture sit for a while, the sand will settle to the bottom of the jar. But if you add salt to water and shake them up, the salt dissolves in the water. You can set the jar of salt water aside for a while, but the salt will not settle to the bottom of the jar because they are no longer two separate things. The salt and water form a solution.

Gases can also be mixed with liquids. Soda pop is a mixture of gases and liquids. The bubbles you see rise to the top of a glass of soda pop are gases moving to the surface. Two liquids can be mixed together, such as apple juice and grape juice. You can also mix solids with solids and gases with gases. For example, mixing sand and sugar together just gives you a mixture of sand and sugar. The air you breathe is a mixture of about fourteen different kinds of gases.

Soda is a mixture of liquids and gases.

Think About It

How could you separate sand and sugar that have been mixed together?

Hint: One option is by using a magnifying glass and a toothpick.

Do You Know?

You can separate the salt from a solution of salt water by letting the water evaporate. When all the water has evaporated into the surrounding air, the salt is left behind.

Mixtures are a type of **physical change.** During a physical change, the properties of the substances that are mixed together do not change. When you mix salt with water, it still acts, looks, and behaves like water but tastes salty. The same is true if you add sugar to water—only the taste changes.

Conclusion

Everything that takes up space is made of matter. Common states of matter are solids, liquids, and gases. Many substances we use every day—such as soda pop, bicycles, and ice cream with chocolate chips—are combinations of solids, liquids, or gases.

By adding or taking away heat energy, matter can change from one state to another. Water is a common substance that we see change between a solid, liquid, and gas almost every day. Where might you find all three states of water on the same day?

Can you see all three states of water at once?

Glossary

condenses changes states from a gas to a liquid, mainly due to the temperature getting cooler (p. 13)

evaporates changes states from a liquid to a gas, mainly due to the temperature getting warmer (p. 12)

gas matter that can freely change shape and size; often it can't be seen (p. 9)

liquid matter that keeps its size but takes the shape of its container (p. 7)

matter anything that takes up space and has weight (p. 5)

mixture a combination of substances in which a chemical reaction does not occur (p. 15)

physical change a change in the size, shape, or color of a substance that does not change it into a different substance (p. 19)

properties features or qualities that can be used to describe something (p. 4)

solid matter that keeps its shape and size (p. 6)

solution a mixture in which one substance is spread evenly through another substance, such as a solid dissolving in a liquid and becoming invisible (p. 16)

states of matter the solid, liquid, or gaseous condition of a substance (p. 6)

substances particular kinds of materials (p. 4)

temperature the measure of how hot or cold something is (p. 4)

water vapor the state of water in which it is an invisible gas (p. 12)

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