BACKGROUND INFORMATION

As previously discussed, all molecules are in constant motion due to their innate thermal energy. As a solid is heated, the motion of the molecules that make it up increases until, eventually, the molecules break loose from their fixed positions and the solid becomes a liquid.

As more heat energy is applied to a liquid, single molecules actually break away from the surface of the liquid. These loose molecules form a ***gas.***

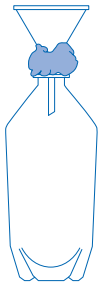
A gas has no definite shape and no definite volume. A gas expands to fit the shape and fill the volume of its container. Gases do not hold their shape or volume.

In a gas, intermolecular forces are quite weak and the molecules are far apart. They move around freely at high speed, continually bouncing off each other or the walls of their container and setting off in new directions. The net effect of these collisions with the walls of the container is observed as gas pressure.

▼ Activity Sheet 3, Part A

What Is a Gas?

1. Put the funnel in the bottle. Seal the neck of the bottle to the funnel with clay, as shown.



2. Pour the colored water from the tumbler all at once into the funnel.

   What happened to the water?

   Most of it stayed in the funnel and did not go down into the bottle.

3. Loosen the clay seal from around the neck of the bottle and funnel.

   a. What happened to the water? It went through the funnel into the bottle.

   b. Why? The air could get out of the bottle around the neck of the funnel, and the water could get in through the funnel.

▼ Activity Sheet 3, Part B

What Is a Gas?

4. a. Look at the blown-up balloon. Suppose you press on the balloon. What do you predict will happen to the balloon's shape?

   Answers will vary.

   b. What do you predict will happen to the shape of the air inside the balloon?

   Answers will vary.

5. Press gently on the balloon.

   a. What happened to the shape of the balloon when you pressed on it?

   It changed; it got flatter.

   b. What happened to the shape of the air inside the balloon when you pressed on the balloon?

   It changed; it got flatter.

Guiding the Activity

Session I

1 Give each team of four an empty plastic bottle. Ask, **Is there anything in the bottle?**

Students will probably say no.

Tell students they will do an experiment to find out the answer to the question.

2 Give each team of four a funnel, a tumbler of colored water, a lump of clay, and several paper towels. Give each student a copy of **Activity Sheet 3, Part A.**

Instruct students to place the funnel in the bottle and secure it with clay so that the funnel is sealed to the plastic bottle, as shown on the activity sheet. Make sure they press tightly on the clay.

Tell students to pour the colored water all at once into the funnel and observe what happens (see Figure 3-1). Have them record their observations on the activity sheet.

▲ ***Figure 3-1.*** *Pouring water into the funnel.*

3 Ask students, **What keeps the water from entering the bottle?**

Accept all reasonable answers.

Ask, **What do you think could be in the bottle that is preventing the water from going in?**

Some students may say air.

Explain that the bottle contains air.

4 Tell students to loosen the clay from around the bottle neck and record their observations.

Ask, **What happened to the water when you loosened the clay?**

The water went into the bottle.

Ask, **Why can the water get into the bottle now?**

Accept all ideas.

Additional Information

Guiding the Activity

Guiding the Activity	Additional Information
Tell students that the water can get in because the air can get out where the clay was loosened. When the air leaves the bottle, there is room for the water. Lead students to conclude that air is a thing that takes up space.	
5 Ask, **What kind of a material is air? Is it a solid? Is it a liquid?**	*Accept all answers. Most students will say no, it is neither a solid nor a liquid.*
Write the word **gas** on the board. Tell students that air is made of gases. Remind students that, in the previous activity, the liquid they measured took up a certain amount of space; it had a certain size, or volume.	
Ask, **Although you cannot see air, do you think it has volume?**	*Yes, because it takes up space.*
Tell students that in the next session they will find out more about the properties of gases. Have students discard the clay. Ask them to wipe any traces of clay from the funnels and the bottles with paper towels. Have them rinse the funnels, plastic bottles, and tumblers, allow them to air-dry, and return them to the kit.	
Session II	
6 Tell students that in this session they will investigate what happens to the shape of a gas—air—when the shape of its container changes. Tell students that balloons will be the containers for the air.	*You may wish to explain that because air is hard to move (like a solid) or pour (like a liquid), students will not be putting it into two different containers. Instead, they will be changing the shape of the container the air is in (the balloon) and then comparing the shape of the air inside it.*

Guiding the Activity

		Additional Information
	Blow up a balloon and twist the neck of the balloon to keep the air from escaping. Tie the short piece of string tightly around the neck of the balloon.	*The balloon should be about the diameter of an orange when inflated.*
	Have the adult volunteer or older student blow up the balloons and tie them shut with strings. Distribute two blown-up balloons to each team of four.	
7	Have each team set their blown-up balloons on the desk in front of them. Ask, **What is in the balloons?**	*Students should respond that their balloons are full of air.*
	Distribute a copy of **Activity Sheet 3, Part B,** to each student.	
	Ask, **What do you think will happen to the shape of the balloons when you press on them?**	*Accept all reasonable answers. Students may predict that it will be flatter.*
	Ask, **What do you think will happen to the shape of the air inside the balloons when you press on the balloons?**	*Accept all reasonable answers. Students may predict that it will be flatter and become the same shape as the balloon.*
	Tell students to record their predictions on the activity sheet.	
	Instruct students to test their predictions. Have them press gently on the balloons and record their observations on the activity sheet.	
8	Ask, **What happened to the shape of the balloons when you pressed on them?**	*It changed.*
	Ask, **What happened to the shape of the air inside the balloons when you pressed on the balloons?**	*It changed.*
	To conclude, ask, **What happens to the shape of a gas when the shape of its container is changed?**	*The shape of the gas changes depending on the container.*

Guiding the Activity

	Additional Information
9 Remind students about their findings from Session I—although we can't see gases, they take up space and have volume. Tell students that gases do not hold their shape or volume.	
To review, ask, **What did you learn about the shape of a solid when the shape of its container changes?**	*It stays the same.*
Ask, **What did you learn about the volume (size) of a solid when the size of its container changes?**	*It stays the same.*
Ask, **What did you learn about the shape of a liquid when the shape of its container changes?**	*It changes to fit the shape of the container.*
Ask, **What did you learn about the volume of a liquid when the volume of its container changes?**	*It stays the same.*
10 Write the term *states of matter* on the board. Tell students that **states of matter** are three conditions a substance can be in: solid, liquid, or gas. Explain to students that on Earth everything that takes up space is called *matter,* and that matter may be in one of three states—solid, liquid, or gas.	*At this time you may choose to draw Figure 1-1 on page 14 on the board for your students .*
Ask, **What are some solids with which you are familiar?**	*Students may mention wood, metal, plastic, and so on.*
Ask, **What are some liquids with which you are familiar?**	*Students may mention water, milk, lemonade, and so on.*
Ask, **What are some gases with which you are familiar?**	*Students may mention air, water vapor, or gas for cooking or home heating. Odors from perfume, food cooking, and skunks are also gases.*

Reinforcement

Have students scrunch a piece of paper towel into the bottom of a cup. Have them hold the cup upside down and push it down into a pail of water. Help them conclude that the paper does not get wet because the cup is full of air.

Science Journals

Have students place their completed activity sheets in their science journals.

Cleanup

Have students discard the balloons and the pieces of tape and string. Return the rolls of string and masking tape to the kit.

Science at Home

Have students watch and listen for the word *gas* in television commercials, on billboards, in newspapers, and in other places. Have them write down all the places where they hear about gases.

Connections

Science Challenge

Do the following activity as a demonstration. Blow up two large balloons to the same size, tie them closed securely, and tape them to the ends of a long dowel. Hang the dowel from a string so the two balloons balance each other. Then pop one balloon with a pin. (The other end will tip downward.) Gather up all the pieces of the popped balloon and tie them to the dowel again. (The other end will rise only partway.) Ask students to explain this. (The air inside the balloons has weight. Popping one balloon released the air inside it and made it lighter than the inflated balloon.)

Science Extension

Tell students that another difference between liquids and gases is that gases can be squeezed (compressed) but liquids cannot. The following activity demonstrates this: Give each team an empty plastic soda bottle. Tell students to screw the cap on tightly and then squeeze the bottle as hard as they can. (They should be able to compress the bottle a noticeable amount.) Then have each team fill its bottle to the brim with water, replace the cap, and squeeze again. (Students will be able to compress the bottle only slightly, if at all.)

Science and Careers

Invite a professional or hobbyist clown who entertains at children's parties or in hospitals to visit the class and show students how to make animals with inflated balloons.

Science and Language Arts

- Challenge students to transform the word *gas* to *lip* by changing one letter at a time. Tell them that each change must create a real word, not a nonsense syllable. (One possibility is *gas* → *gap* → *lap* → *lip*.) Let students compare their solutions. Encourage them to make up their own word puzzles for the rest of the class to solve.

- Obtain a copy of *What Is the World Made Of?* by Kathleen Weidner Zoehfeld, an easy-to-read book describing the states of matter. Read the book aloud to small groups or make it available for students to read independently.

Science and Math

As a follow-up to the first Science and Math connection in Activity 2, tell students that the volume of gases is also measured in cubic centimeters. Ask students to figure out a way to determine the volume of all the air in the classroom. If they do not suggest it, guide them to recall the formula $l \times w \times h$. Let students measure the room's dimensions and calculate its volume. Help them convert cubic centimeters to cubic meters. Also point out that the volume of the air in the room is actually less than the volume of the room itself because solid objects—including themselves—take up some of the room's space.

Science, Technology, and Society

As appropriate, encourage supervised use of the Internet for research projects related to properties of solids, liquids, and gases. A list of related websites is provided in the References and Resources section.