

What Is a Liquid?

OBJECTIVES

Students observe and measure a liquid in different containers in order to determine the properties of liquids.

The students

pour a measured amount of liquid from one container into another

compare the liquid's shape and volume in one container to its shape and volume in the other

conclude that a liquid can change shape but not volume when moved from one container to another

SCHEDULE

About 40 minutes

VOCABULARY

cubic centimeter (cm^3 , or cc)
liquid
volume

MATERIALS

For each student

1 Activity Sheet 2

For each team of two

1 cup, paper, 6-oz

1 cup, plastic, 1-oz

1 tumbler, graduated

For the class

paper towels*
water, tap*

*provided by the teacher

*Ready
and waiting!*

PREPARATION

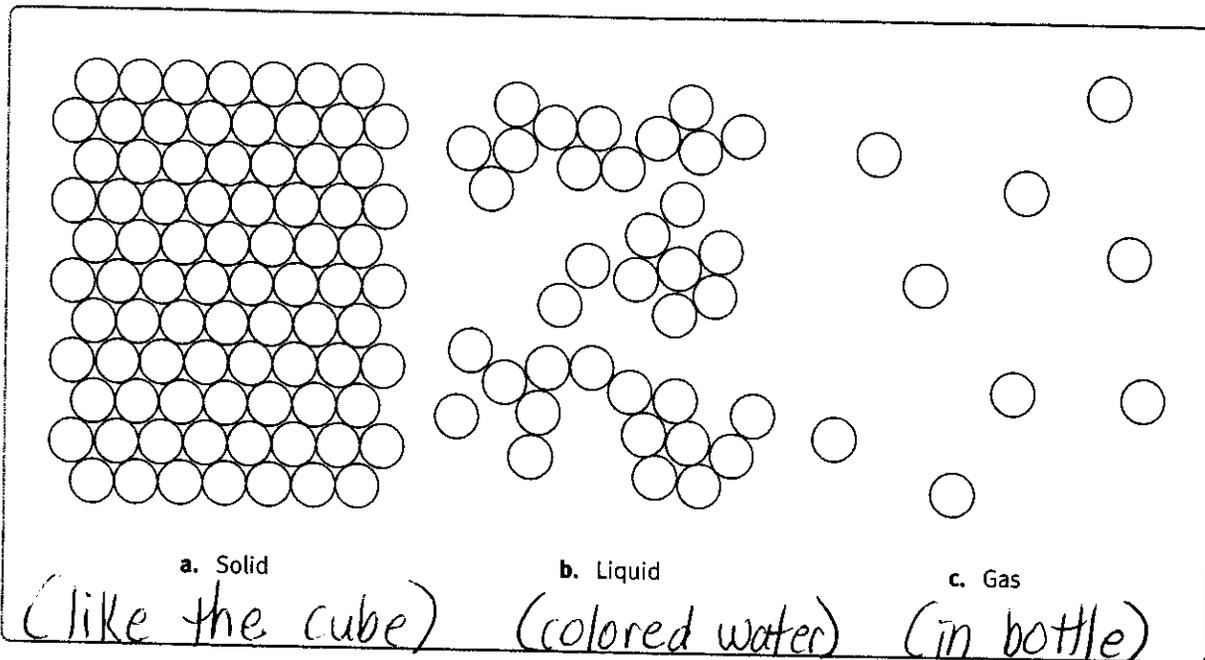
- 1 Make a copy of Activity Sheet 2 for each student.
- 2 Fill a paper cup about one-third full for each team.
- 3 Each team of two will need a paper cup of water, a 1-oz plastic cup, and a graduated tumbler. Have paper towels on hand to clean up spills.

BACKGROUND INFORMATION

As previously explained, molecules in a solid are held in place by the attractive forces of their neighbor molecules and are not free to move around very much (see Figure 2-1). Only a small back-and-forth vibration is possible. Adding heat, however, gives them more energy. As a result, they rotate and vibrate more strongly, increasing their tendency to move around randomly. Given sufficient added heat, a solid will change state and become a **liquid**.

As a liquid, the matter still has a definite volume, but it has lost its definite shape. When a liquid is poured, it flows; the attraction among its molecules is still strong enough to hold them together, but not as rigidly as they are held together in a solid. When liquid is poured from one container into another, the shape of a liquid changes to fit the shape of the container.





▲ **Figure 2-1.** Circles represent the arrangement of molecules in a solid, a liquid, and a gas.

Volume is measured in cubic units; volume measurements in these activities are expressed in units of the metric system, which is based on the length of one meter. In the previous activity, students measured the dimensions of a solid block in centimeters ($100\text{ cm} = 1\text{ m}$). The volume of a block, calculated using the formula $V = l \times w \times h$, is expressed in **cubic centimeters** (cm^3 , or cc).

In this activity, students measure the volume of a given amount of liquid in cups whose graduations are marked in cubic centimeters. Although the cups show the abbreviation cc , the more widely accepted abbreviation for cubic centimeters is cm^3 .

▼ **Activity Sheet 2**

What Is a Liquid?

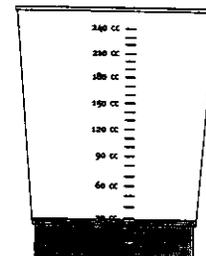
1. Pour water from your paper cup into your small plastic cup to the 30-cc mark. Draw the water level in the illustration. Write the number of cc of water under the picture.



water volume: 30 cc

2. Record your predictions.
 - a. When I pour the water from the small plastic cup into the large plastic cup, I predict the shape of the water will
Accept all answers.
 - b. When I pour the water from the small plastic cup into the large plastic cup, I predict the volume of the water will
Accept all answers.

3. Pour water from the small plastic cup into the large plastic cup. Draw the water level in the illustration. Write the number of cc of water under the picture.



water volume: 30 cc

4. What happened to the shape of the water when it was poured into two different containers?
It changed to fit the container.
5. What happened to the volume of the water when it was poured into two different containers?
It stayed the same.

Guiding the Activity

- 1 Give each team of two a paper cup containing water. Tell students to examine the contents of the cup. Ask, **What is in this cup?**

Ask, **How would you describe this material? Is it a solid?**

If students do not mention it, bring out the idea that water is a liquid. Write the word *liquid* on the board. Ask students, **How can you tell that this material is a liquid?**

Tell students that **liquid** is a state of matter that has a definite volume.

Tell students that in this activity, they will learn how to tell if a material is a liquid.

- 2 Write the word *volume* on the board. Ask students, **What does the word volume mean?**

If students do not know, tell them that **volume** means *size*—the amount of space a material takes up. Remind students that, in the previous activity, each block they measured took up a certain amount of space; it had a certain size, or volume. Tell students that the volume of a liquid, like the volume of a solid, can be measured, too. Ask, **How do you think you could find the volume of a liquid?**

Tell students they will measure a certain amount of water using special kinds of measuring cups.

- 3 Tell students to pour water from the paper cup into the small plastic cup up to the 30-cc mark. Ask, **What is the volume of the water in the plastic cup?**

Ask students, **What do you think will happen to the shape of the water in the small plastic cup when it is poured into the tumbler?**

Additional Information

Students should recognize that it is water.

Most students will probably say no, that it is a liquid.

Accept all ideas at this time.

Accept all reasonable answers.

Accept all ideas. Students may suggest putting it in a measuring cup.

Students should all be able to say that the volume of water is 30 cc (or 30 cubic centimeters).

Accept all ideas. Students may suggest that it will change shape, become wider and flatter, because the large cup is wider at the bottom than the small cup.



Guiding the Activity

Ask students, **What do you think will happen to the volume of the water in the small plastic cup when it is placed in the tumbler?**

Give each student a copy of **Activity Sheet 2**. Tell students first to draw the water level in the small plastic cup and to record the volume of water in cubic centimeters beneath it on their activity sheets. Then have them record their predictions on the activity sheet.

4 **7** Instruct students to test their predictions by pouring the water from the small plastic cup into the tumbler (see Figure 2-3). Have them draw the water level in the large cup and record the volume of water in cubic centimeters beneath it on their activity sheets.

Ask students, **What happened to the shape of the water when you moved it from one container to another?**

Ask, **What happened to the volume of water when you moved it from one container to another?**

Additional Information

Accept all ideas. Students may suggest that it will stay the same.



▲ **Figure 2-3.** *Students observe the shape and volume of water in two different containers.*

The shape changed to fit the shape of the container it was in.

The volume remained the same—30 cc. (A small amount of water may have been left behind when it was poured into the second container, but this amount should be negligible.)

Guiding the Activity

Ask students, **What happened to the shape and volume of the solid you tested in the last activity when you moved it from one place to another?**

Ask, **In what way is a solid the same as a liquid?**

Ask, **In what way is a solid different from a liquid?**

7 Ask, **How can you tell if something is a liquid?**

Ask students, **What are some other liquids with which you are familiar?**

Allow students time to share their experiences with liquids.

Additional Information

Its shape and size, or volume, remained the same.

They both stay the same size (or volume) when moved from one place to another.

A solid retains its shape, but a liquid changes shape in differently shaped containers.

It is a liquid if it does not change in volume but does change in shape when it is moved from one container to another.

Answers will vary. Students may mention milk, carbonated drinks, lemonade, oil, vinegar, syrup, and so on.

Properties of Gases

OBJECTIVES

Students are introduced to gases. They observe some properties of air and then infer properties of gases in general.

The students

- describe properties of air
- observe a demonstration that shows the physical presence of air
- infer properties of gases in general

SCHEDULE

About 40 minutes

VOCABULARY

gas

MATERIALS

For each student

1 Activity Sheet 9

For each team of two

1 bag, paper

For the class

1 bottle, plastic
 1 chart, Describing Properties (from Activity 8)*
 1 piece clay (from Activity 7)*
 1 btl food coloring, red
 funnel, plastic
 1 marker, felt-tip*

1 sheet paper, tissue*
 paper towels*
 1 pencil, sharpened*
 1 pitcher*
 1 spoon, plastic
 water, tap*

*provided by the teacher

Ready
and waiting!

PREPARATION

- 1 Make a copy of Activity Sheet 9 for each student.
- 2 Fill a pitcher with water, add a few drops of red food coloring, and stir with a plastic spoon.
- 3 You will need the following materials for a class demonstration at the start of the activity: a plastic bottle, a piece of clay, a funnel, some paper towels, a sheet of tissue paper, a sharpened pencil, and a pitcher of colored water.
- 4 Each team of two will need a paper bag.

BACKGROUND INFORMATION

Gases are the third state in which matter can exist. Gases tend to be colorless and transparent, although some, like ammonia, have a strong smell. Like solids and liquids, gases are made of molecules, but the molecules of a gas are very far apart and move at high speeds in all directions.

As a result, gases have no definite volume or shape. They expand to fill any space available. You can change the amount of space a gas occupies by heating or cooling it or by putting pressure on it.

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**.

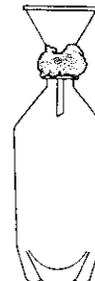
A gas has no definite shape and no definite volume. A gas expands to fit the shape and fill the volume of its container. Gases do not hold their shape or volume.

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.

Guiding the Activity

Session 1

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

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.

** Ask students to predict what will happen.*
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.

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

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

Explain that the bottle contains air.

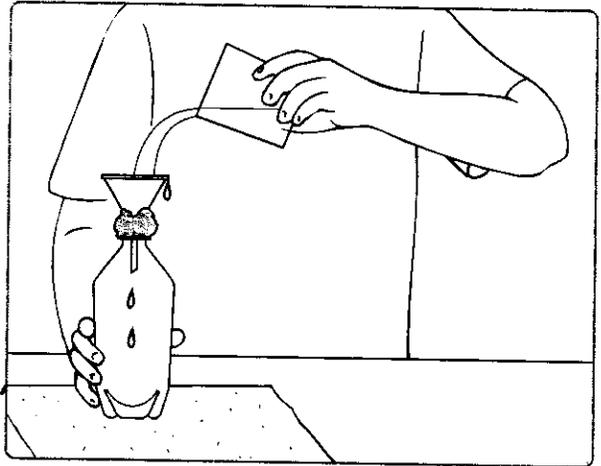
- 4 Tell students to loosen the clay from around the bottle neck and record their observations.

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

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

Additional Information

Students will probably say no.



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

Accept all reasonable answers.

Some students may say air.

The water went into the bottle.

Accept all ideas.

Guiding the Activity

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.

Additional Information

- 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 **a bag** will be the containers for the air.

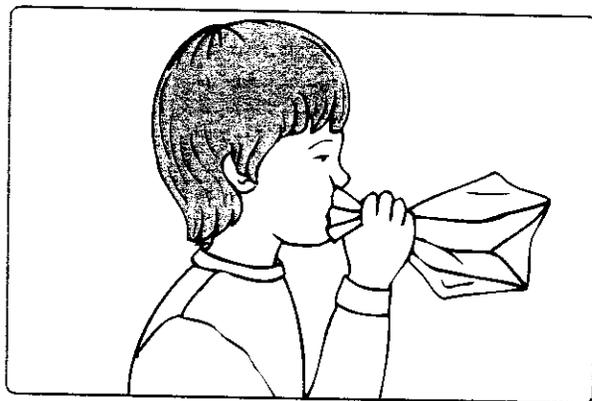
You may wish to explain that because air is hard to move (like a solid) or pour (like a liquid), students will not be putting it into two different containers. Instead, they will be changing the shape of the container the air is in (the bag) and then comparing the shape of the air inside it.

Guiding the Activity

To summarize, ask, **Why did the water suddenly flow into the bottle after I poked a hole in the clay?**

- 6 Give each team a paper bag and tell them to open it. Ask, **What is in your paper bag?**

Tell each team to blow into the paper bag and show students how to twist the end of the bag and hold it closed (see Figures 9-4 and 9-5). Stimulate class discussion by asking, **What happens to the bag when you blow into it? What are you putting into the bag when you blow it up?**



▲ Figure 9-4. Blowing air into a paper bag.

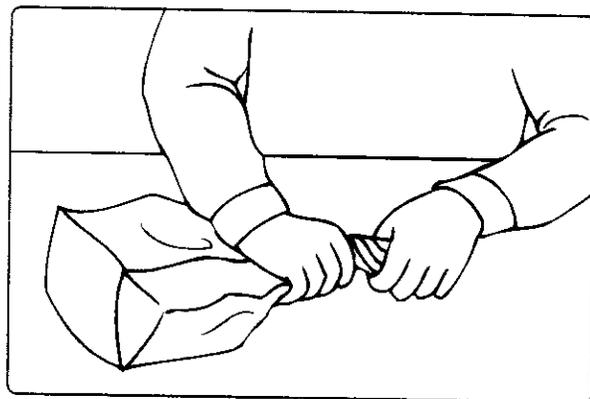
Encourage students to name some properties of air that you can add to the list on the board. Guide students by naming the properties they used to describe the blocks and the water and by asking questions, such as, **Blocks have their own shape, and their shape does not change very easily. Does the air in the bag have its own shape?**

Additional Information

Students should conclude that all of the water initially could not flow into the bottle because the bottle was filled with air. When you poked a hole in the clay, the air was pushed out of the bottle as the water flowed into it.

Some students might say that the bag is empty; others might remember that there is some air in the bag.

Students should say that the bag gets bigger as it fills with the "air" they are blowing into it.



▲ Figure 9-5. Twisting the paper bag closed.

Students should say that the shape of the air can be changed by squeezing the bag, so air, like water, takes the shape of its container.

Guiding the Activity

Write *changes shape* on the board.

Ask, **We were able to pour the water from one cup to another cup easily. We could pour it on the tray easily too. Can you move air easily? Does air flow?**

Write *moves easily* on the board.

- 7 Read back the properties of air to the students. Write the word *gas* on the board and tell students that air is a gas. Encourage students to think of other gases.

Explain to students that helium and carbon dioxide, like air, are gases and, therefore, have similar properties. Review the properties of air listed on the board. Ask students to identify those that are common to all gases.

Add these common properties to the Describing Properties chart under the heading *Properties of Gases*.

- Distribute a copy of **Activity Sheet 9** to each student. Have students complete their activity sheets. Ask, **Which of the drawings show things that contain a gas?**

Additional Information

Students should say that they can move air easily; it flows. Students can show that air flows by opening their bags and pouring the air out onto the table as they press down on the top of the bag.

Examples of gases that students might be familiar with include helium in balloons and carbon dioxide in soda.

*Lead students to conclude that all **gases** move easily and take the shape of their container. Most gases have no color and so cannot be seen.*

Help students read the instructions.

Students should say that the hot air balloon (air), the tire (air), the balloon (air), the empty jar (air), the can of soda (carbon dioxide), and the scuba diver's air tanks (air) all contain gases.

REINFORCEMENT

Have students write down or draw as many things as they can think of that are filled with or contain gases, such as car tires, bicycle tires, balloons, and soda.

SCIENCE JOURNALS

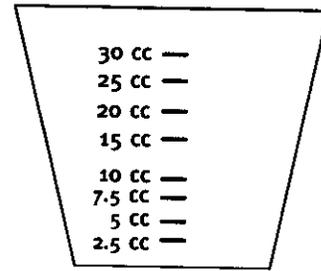
Have students place their completed activity sheets in their science journals.

CLEANUP

Return the plastic bottle, food coloring, funnel, and plastic spoon to the kit. Store the clay in the resealable plastic bag. Have students discard the paper bags. Leave the chart on display for use in Activity 12 or return it to the kit.

What Is a Liquid?

1. Pour water from your paper cup into your small plastic cup to the 30-cc mark. Draw the water level in the illustration. Write the number of cc of water under the picture.

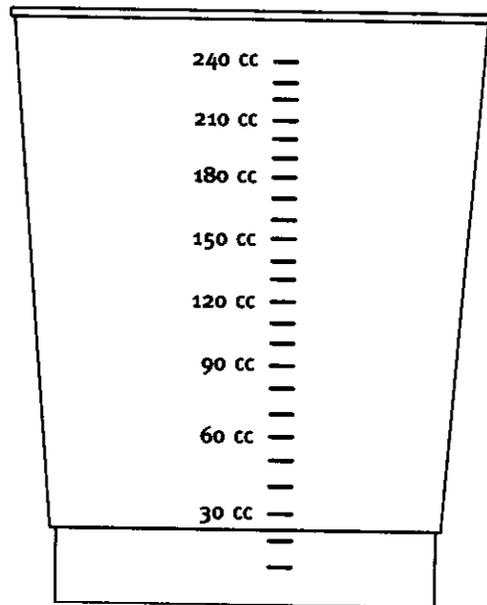


water volume: _____ cc

2. Record your predictions.
 - a. When I pour the water from the small plastic cup into the large plastic cup, I predict the shape of the water will

 - b. When I pour the water from the small plastic cup into the large plastic cup, I predict the volume of the water will

3. Pour water from the small plastic cup into the large plastic cup. Draw the water level in the illustration. Write the number of cc of water under the picture.
4. What happened to the shape of the water when it was poured into two different containers?

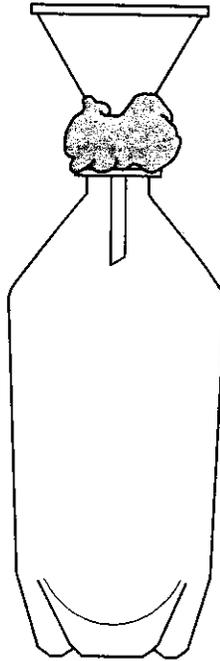


water volume: _____ cc

5. What happened to the volume of the water when it was poured into two different containers?

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?

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

a. What happened to the water? _____

b. Why? _____
