Materials List

Qty		Description
3	c	alcohol, 1 qt
1	c	aluminum foil
3	c	ammonia, 2 oz
1		bag, reclosable
1	c	baking soda, 4 oz
16		bases, balance
17		beads, wooden
16		beams, balance
8		†bottles, 2-L, drilled
16		caps, for tubes
1		clay, modeling
32		containers, plastic, with lids
3	c	cooking oil, 16 oz
17		cubes, plastic
80		cups, plastic, 1-oz
16		cups, plastic, 4-oz
32		cups, soufflé
48		dropper bottles
32		droppers
1	c	food coloring, blue
1	c	food coloring, green
1	c	food coloring, red
1	c	glycerin, 4 oz
1	c	glycerin, 32 oz
75		hooks
2	c	labels, p/100
3	c	litmus paper, blue, p/100
3	c	litmus paper, red, p/100
8		pans, aluminum
1	c	paper clips
3	c	paper, blotter
32		petri dishes
16		pins, balance

Qty		Description
16		plate sets
1	c	soap, liquid, 10 oz
1	c	tape, masking
1	c	thread
1	c	toothpicks, p/750
16		tubes, plastic
1	c	vinegar, 16 oz
16		washers, p/100
1	c	waxed paper
1		teacher's guide

Teacher provided items

–	c	antacid tablets
–	c	apple juice
–	c	crayons
1		glass jar
1	c	grape
1		hole punch
–	c	lemon juice
1		marker, permanent
–	c	milk
–	c	paper towels
1		penny
–		pitchers
8		rulers, metric
32		safety goggles
16		scissors
1	c	soft drink, carbonated
3		spoons
1		teaspoon
–	c	water, tap

† = in separate box
c = consumable item

Activity 10
Water Pressure

Objectives

Students investigate the concept of water pressure. They observe the effects of pressure on water at different depths and conclude that water's weight causes an increase in its pressure that is directly proportional to the increase in its depth.

The students

- construct a setup to investigate whether water exerts pressure
- infer that water pressure increases with depth
- operationally define *water pressure*

Schedule

About 40 minutes

Vocabulary

pressure
water pressure

Materials

For each student
1 Activity Sheet 10

For each team of four
1 bottle, 2-L, pre-drilled
1 pan, aluminum
1 *ruler, metric

For the class
*pitchers
1 roll tape, masking
*water, tap

*provided by the teacher

Preparation

1. Make a copy of Activity Sheet 10 for each student.
2. Borrow one team's materials to make a demonstration water-pressure setup: Put a piece of tape over both holes on one of the bottles. Fill the bottle with tap water. Place the bottle, an aluminum pan, and a ruler where all the students can see them.
3. Fill several pitchers with tap water. Set up a distribution station where students will have access to the masking tape and water.
4. Each team of four will need an aluminum pan, a 2-L bottle with holes, and a metric ruler.

Background Information

Pressure is the amount of force exerted on an area. *Water pressure* is the amount of force exerted on an area of water by the volume of water above it. Water pressure is directly proportional to the depth of the water.

You can feel the increase in water pressure on your eardrums when you swim to the bottom of a pool. This is because water pressure increases as depth increases.

A model can be made to demonstrate that water pressure increases with depth. Water allowed to escape from holes in the side of a bottle full of water will squirt farthest from the hole nearest the bottom.

In this activity, students use such a model to observe and record degrees of water pressure at different depths.

Name _____ Activity Sheet 10

Water Pressure

1. Predict how far the water will squirt out of the top hole.

Predictions will vary.

Predict how far the water will squirt out of the bottom hole.

Predictions will vary.

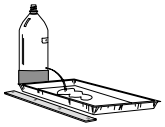
From which hole do you predict water will squirt the farthest?

Predictions will vary.

2. Construct the setup as shown below. Tape the holes and fill the bottle with tap water. After the bottle is in position (as shown below), remove the tape from the top hole and measure how far the water squirts. Replace the tape and refill the bottle. Remove the tape from the bottom hole and measure how far the water squirts. Record your data below.

Top hole: _____

Bottom hole: _____



What do you think is the relationship between the depth of the water at the level of the hole and how far the water squirted from that hole?

The deeper the water (the lower the hole), the farther the water squirted.

Why is this true? Include the term *water pressure* in your explanation.

Water pressure increases with depth, and the greater the pressure, the farther the water will squirt.

What can you infer about the relationship between pressure and depth of other liquids?

I expect the pressure of other liquids also increases with depth.

Teaching Suggestions

Additional Information

1

Write the word *pressure* on the board. Define it for students as the force put on something by something in direct contact with it.

Remind students that in Activity 8 they concluded that liquids have weight. Ask, **If liquids have weight, do you think they can exert pressure?**

Responses will vary. Encourage responses that involve the downward pressure on a scale or balance arm when the liquids were weighed.

Discuss examples of pressure with which students are familiar. They have probably experienced water pressure on their eardrums as they swam toward the bottom of a pool. Many will have felt changes in air pressure—also on their eardrums—if they have flown in an airplane or ridden in a car in mountainous country.

2

Display the setup for investigating water pressure—the 2-L bottle, the aluminum pan, and the ruler. Point out that there are two holes in the bottle, both covered with

masking tape, and that the bottle is full of water.

Ask, **What do you think would happen if I removed the tape from the bottom hole?**

Most students will respond that water will squirt out.

3

Ask, **How far do you think the water will squirt when it is allowed to escape from the top hole? From the bottom hole?**

Exact lengths are not important. Accept all reasonable responses.

From which hole do you think the water will squirt farther?

Predictions may vary. Have students record all of their predictions on their activity sheets.

Explain that in this activity they will construct a setup to investigate water pressure. Tell them that they will be measuring the distance the liquid squirts as it escapes the bottle from either of the two holes.

When you are finished with the setup demonstration, empty the bottle, remove the tape from the holes, and return it with the pan and ruler to the distribution station for one of the teams to use.

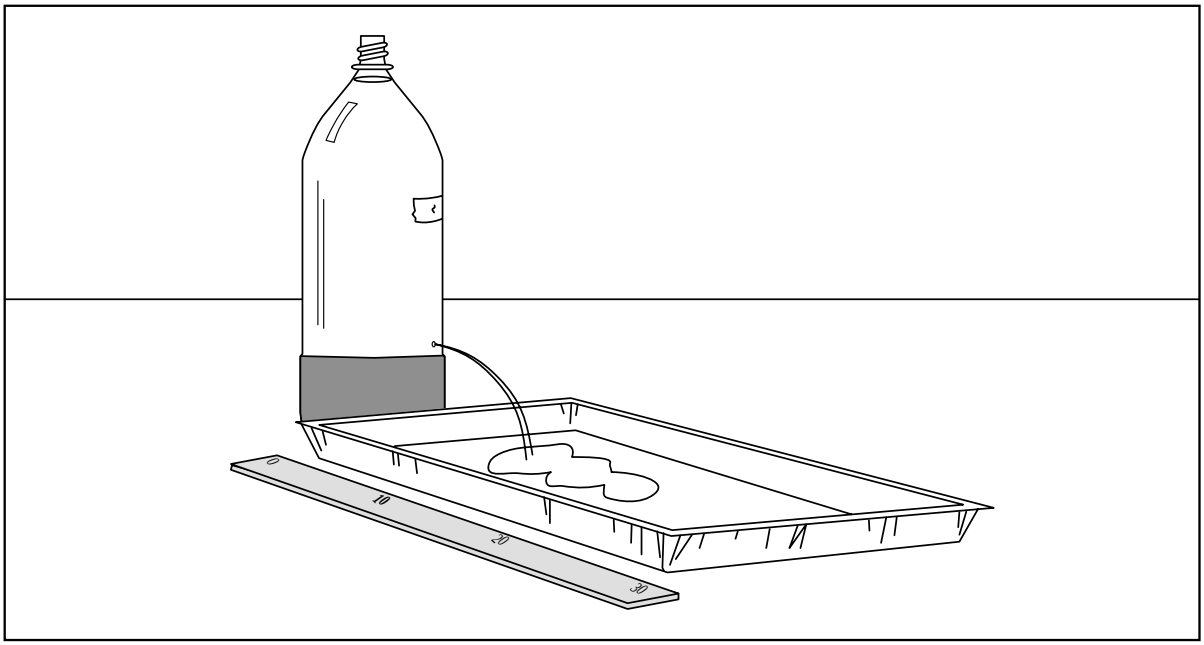


Figure 10-1. How far will the water squirt?

4

Distribute Activity Sheet 10 to each student. Give each team of four a pre-drilled bottle, a pan, and a ruler. Teams should have access to masking tape and water at the distribution station. Tell students to follow the instructions on the activity sheet and to record their observations and measurements.

After teams have finished their investigation of water pressure, write the words *water pressure* on the board and define it as the force, or weight, of water pressing on water.

5 Remind students of what they know about pressure—that it is the force put on something by something in direct contact with it.

Ask, **What do you think the water pressure is like at the bottom of the bottle compared with the pressure at the top of the bottle?**

6 Students should infer that the pressure is greater at the bottom of the bottle.

Ask, **What do you think is the relationship between the depth of the water at the level of a hole, the water pressure there, and the distance the water squirts from that hole?**

The greater the depth, the greater the pressure, and the farther the water squirts.

Explain that the water in the bottle squirted farther from the bottom hole because the weight of the water above the level of the bottom hole was greater than the weight of the water above the level of the top hole. The deeper the water, the greater the water pressure at the bottom.

Add that pressure increases with depth in all liquids, not only water, because as depth increases, so does the weight of the liquid above.

Have students complete their activity sheets.

Reinforcement

Ask students if another liquid in the bottle, such as oil or glycerin, would still squirt farthest from the bottom hole. Students should infer that the distance the liquid squirts is related to the pressure of liquid on

R itself—the weight of liquid above on liquid below. Pressure increases as the depth of the liquid increases. Therefore, any liquid would always squirt farthest from the bottom hole.

Cleanup

Have students discard the water and the pieces of tape. Bottles and pans should be

C air-dried and returned with the roll of tape to the kit.

Connections

Science Challenge

Build the following device, called a *Cartesian diver,* to demonstrate to the class. Fill a tall jar with water. Fill an eye dropper partway with water and put it in the jar. Adjust the amount of water in the dropper so it barely floats at the top of the jar. Make sure the water comes right up to the jar's rim, then stretch a piece of rubber cut from a balloon over the top of the jar and secure it in place with string or a rubber band. When you press down on the rubber, the dropper sinks to the bottom of the jar. When you release your hand, the dropper rises again. Demonstrate the diver to the class, and give students a day or two to take turns using it. In a class discussion, ask students to suggest how it works. (Pressing down on the rubber increases the pressure in the jar, which decreases the size of the bubble in the dropper. The bubble is no longer large enough to keep the dropper afloat. Releasing the rubber restores the bubble to its original size and the dropper rises again.)

Science Extension

Suggest that each team test other liquids, including alcohol, glycerin, cooking oil, and liquids from the first Science Extension in Activity 1. Students will discover that although the specific distances may vary, every liquid produces a shorter stream from the top hole and a longer stream from the bottom hole.

As a follow-up to the above activity, students could test the "squirtability" of different liquids. Tell them to put tape over the top hole and measure the length of each liquid's stream from the bottom hole. Have students list the liquids in sequence from the shortest to the longest stream produced. (Also see Science and Math below.)

Give students the following instructions for making another device that shows the effect of depth on water pressure. Push the end of a large funnel into one end of a plastic tube 1 to 1.5 m (3 to 5 ft) in length. Cover the other end of the tube with tape, and punch a pinhole in the middle. With the funnel and the other end of the tube held at the same height, pour water into the funnel until it and the tube are full. Then hold the device over a sink or dishpan, and lower the taped end of the tube. The pressure of the water in the funnel and tube will push water out of the hole. The farther the end is lowered, the greater the pressure on the water and the farther it squirts.

Science and Math

Have students make a bar graph of their results in the second Science Extension above. Tell them to label the vertical axis *Distance* and the horizontal axis *Liquids,* with the liquids sequenced from the shortest to the longest stream produced. Then guide students to compare this graph with the graphs they constructed in Science and Math for Activities 8 and 9. Do the more-dense liquids produce a longer stream than the less-dense liquids? If not, do students see any other relationship between the liquids' densities and the lengths of their streams?

Science, Technology, and Society

Ask students to list as many devices as they can think of that involve pressure in some way—measuring it or using it to move a material or keep it from moving, for example. Devices include a tire pressure gauge, a bicycle pump, and an astronaut's space suit.