LESSON 11

How Much Air Can You Exhale?

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Bubble blowing is an enjoyable way to show your lung capacity!

INTRODUCTION

In the first part of this module, you discovered that the large surface area of the small intestine enables it to absorb large quantities of nutrients. The lungs also have a very efficient design. They contain millions of tiny air sacs, or alveoli. The alveoli make it possible for the lungs to hold and exchange a large quantity of air.

The amount of air you can exhale after taking a deep breath is a clue to how much air your lungs can hold. Just how much is that? You're about to find out!

OBJECTIVES FOR THIS LESSON

Use a sponge and water to model how the lungs hold air.

Graduate and assemble a device that measures the volume of exhaled air.

Determine how much air you can exhale after taking a deep breath.

Discuss the factors that affect how much air you can exhale.

Getting Started

1. You will work in pairs for this lesson. One student from each pair should collect the materials.

2. Remove a sponge, beaker, and graduated cylinder from the plastic box.

3. Pour 30 mL of tap water into the cylinder. Have your lab partner double-check the water level to make sure it is correct. Then pour the water into the beaker.

4. Using the forceps, pick up the sponge by an edge and dip it into the water in the beaker. Let the sponge absorb as much water as it can. Then, using the forceps, lift the sponge out of the water. Let the excess water drip into the beaker.

5. Continue to hold the sponge while your partner pours the water from the beaker into the graduated cylinder. Read the level of water in the graduated cylinder and subtract it from the amount of water you started with. Call this "The Amount of Water Absorbed by the Sponge." Record this amount in your science notebook.

6. Empty the water in the graduated cylinder into the sink or a large container.

MATERIALS FOR LESSON 11

For your group

- 1 plastic box
- 2 sponges
- 2 50-mL graduated cylinders
- 2 250-mL beakers
- 2 forceps
- 4 polyvinyl tubes
- 2 rulers, graduated in liters
- 4 plastic inserts
- 4 cardboard mouthpieces
- 2 black markers
- 2 strips of masking tape
- 2 large resealable plastic storage bags
- 1 small resealable plastic storage bag
- 3 summary boxes
- Water (or access to sink)

7. Now hold the sponge over the beaker. Remove the sponge from the forceps. Squeeze as much water as you can from the sponge into the beaker. Then pour the water you have squeezed out of the sponge into the graduated cylinder. Read the level of water in the cylinder. Record this number as "The Amount of Water I Could Squeeze From the Sponge."

8. Subtract your answer in Step 7 from your answer in Step 5. Record this number as "The Amount of Water Remaining in the Sponge After Squeezing." Discuss the following questions with your group:

A. Was the sponge still wet after you squeezed out as much water as you could? Why or why not?

B. How do you think this activity relates to your lungs and the process of breathing?

9. Discuss your answers to the questions with the class.

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Figure 11.1 *You're about to determine how much air you can exhale!*

Inquiry 11.1
Measuring How Much Air You Can Exhale

PROCEDURE

1. Follow along as your teacher reviews the Procedure. Then design a table in your science notebook to record your results.

2. Look at the ruler. Notice that it is marked in liters. Discuss the following questions:

A. How is this ruler different from other rulers you have seen?

B. What is one important difference between meters and liters?

C. How do you think the ruler was made?

3. Now it is time to prepare your apparatus. Each member of your group will have his or her own apparatus. (When it is completed, it will look like the device shown in Figure 11.1.) The first step is to graduate the tubing, that is, to mark it with the appropriate units of measurement. To do so, follow these steps:

A. Unroll the tubing until approximately 50 cm are stretched out on your desk (see Figure 11.2). Note that one end is open and one end is sealed.

B. Place the ruler underneath the tubing so that the highest mark on the ruler is lined up with the sealed end of the tubing, as shown in Figure 11.2.

C. Label the seal at the closed end of the tubing "6.0 L."

Figure 11.2 *Mark the tubing as shown here.*

D. With a marker, trace the lines that appear on the ruler onto the tubing. Label the lines in the same way in which the ruler is marked. As you move down the tubing, repeat this procedure five more times. Your final mark should be "0.0 L."

E. Once you have reached the 0.0 L mark, measure another 0.1 L of tubing and place a mark at that spot. Cut the tubing at that point. The tubing will then be graduated to 6.0 L.

4. Begin to assemble your apparatus by putting a plastic insert into the tubing. Leave about 2.5 cm of it sticking out, as shown in Figure 11.3. Wrap the extra tubing securely around the plastic insert and fasten the tubing securely to the plastic insert using masking tape (see Figure 11.4). Make sure that air cannot get between the plastic insert and the tubing.

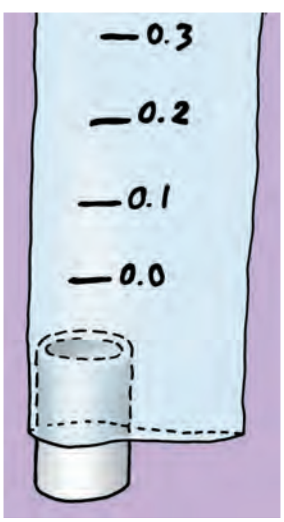


Figure 11.3 *Let about 2.5 cm of the plastic insert stick out of the tube.*

Figure 11.4 *Use masking tape to attach the plastic insert to the tube.*

5. Finally, place the cardboard mouthpiece snugly inside the plastic insert. When complete, your apparatus should look like the one shown in Figure 11.5.

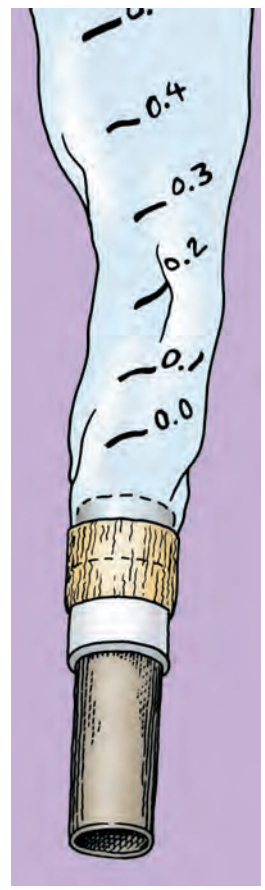


Figure 11.5 *Completed assembly*

6. Now perform the following steps to determine how much air you can exhale.

A. Roll the tubing as close to the mouthpiece as possible.

B. While your partner holds the roll of tubing between both hands, take as deep a breath as you can. Slowly exhale as much air as you can into the tubing. Do not blow into the tubing too hard, because your partner will have trouble holding it as it unrolls. If you are the person holding the tube, move backward slowly as it unwinds.

C. Just before you take the tubing out of your mouth, put one hand on the plastic insert and the other around the tubing. Twist the tube at the end of the insert to keep air from escaping. Your partner will roll the excess tubing toward you.

D. Using the graduations on the tube, determine how much air you exhaled. Record your answer in your science notebook.

E. Repeat the procedure once more. Record the information in your science notebook. Total the results of both trials and determine the average.

F. Reverse roles with your partner and repeat Steps A through E. Make sure you use your own apparatus.

7. Return the laminated ruler to the plastic box. Place your used apparatus into a trash can. Return the plastic box to the designated area.

REFLECTING ON WHAT YOU'VE DONE

1. In the "Getting Started" activity, you determined the following:

- the amount of water absorbed by the sponge
- the amount of water you could squeeze from the sponge
- the amount of water remaining in the sponge after squeezing

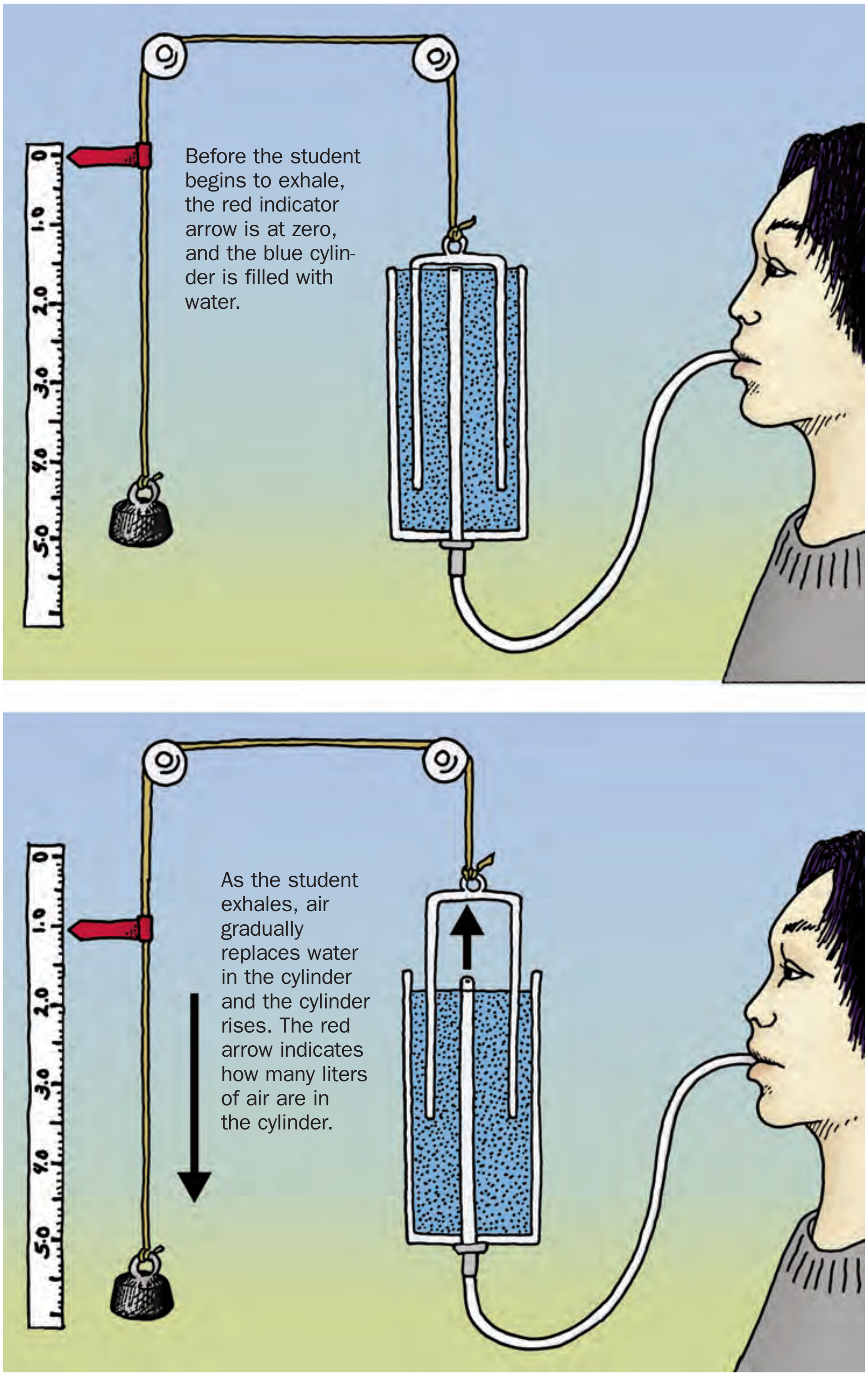
In your science notebook, answer the following questions:

A. Which of these amounts represents the air you could forcibly exhale after taking a deep breath?

B. Which of these amounts represents the air you could not forcibly exhale from your lungs?

C. Which of these amounts represents the total amount of air your lungs can hold when you take your deepest breath?

2. In your science notebook, list at least five things that affect how much air your lungs can hold. Discuss them with the class. Add any new ideas that your classmates suggest.



The spirometer is used to measure vital capacity. The spirometer shown here is an early model. Modern spirometers operate electronically.

UP, UP, AND AWAY!

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Ice and cold are not the only obstacles these mountain climbers face. Can you name another challenge of climbing?

You've probably heard of motion sickness and seasickness. But mountain sickness? What's that?

Mountain sickness is a condition that develops when the blood is not receiving enough oxygen. Mountain climbers may get mountain sickness, because the air at higher elevations contains less oxygen than the air at lower elevations.

The higher you climb, the thinner the air. If you were standing on the peak of a mountain that was 6000 meters high, the air pressure would be just half what it is at sea level. If your breathing did not change, you would be inhaling only half your normal supply of oxygen. Mountaineers who reach the peak of Mt. Everest, which is about 10,000 meters high, are breathing air that contains only about one-third the amount of oxygen present at sea level.

At high altitudes, the lungs can't deliver all the oxygen the body needs. As a result, the heart doesn't have enough oxygen-rich blood to distribute to the cells of the body.

The effects of an oxygen shortage are felt throughout the body. The symptoms include severe headache, fatigue, nausea, and shortness of breath. When experienced mountain climbers develop these symptoms, they know it's time to return to a lower level or to get out their oxygen tanks.

How can you prevent mountain sickness? By proper conditioning. Your body will adjust to higher altitudes if you give it enough time. Shortly after ascending to a higher altitude, you begin to breathe more deeply. Your respiratory system works harder. All the alveoli fill up with each breath. Your heart rate increases, too.

This doesn't happen at sea level, where the lungs don't have to work so hard. Experienced mountaineers take it easy. For example, they may climb about 300 meters higher each day. They usually return to a lower altitude to sleep. This is because people breathe more slowly at night than during the day. This means that they get less oxygen at night, even under the best of circumstances.

Even if you're well conditioned, your body cannot perform as well at high altitudes as it can at sea level. What's more, you don't actually need to get mountain sickness to experience some of the effects of high altitude. Athletes, for example, are very aware of altitude. An Olympic athlete who has trained at sea level will be at a definite disadvantage if the competition takes place 1500 meters higher! ☐

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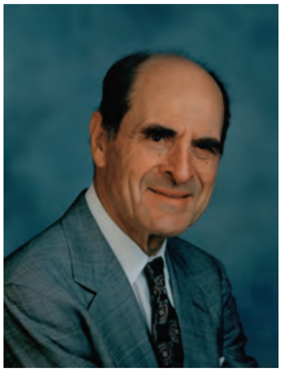
Mountain climbers carry a supply of oxygen and a mask.

Dr. Heimlich's Lifesaving Maneuver



COURTESY OF THE HEIMLICH INSTITUTE

Dr. Henry Heimlich

It's not often that a doctor's name becomes a household word while he's still alive. But this is the case with chest surgeon Henry J. Heimlich. Dr. Heimlich is the inventor of the Heimlich maneuver. He wrote about it in the 1970s, and by 1980, the term "Heimlich maneuver" had entered the dictionary.

The Heimlich maneuver is used to dislodge an object from the windpipe of a person who is choking. If someone cannot breathe or is not getting enough air into his or her lungs, quick action is essential. Without oxygen, the brain will suffer irreversible damage within 4 to 6 minutes.

Before Dr. Heimlich came up with this idea, doctors had been recommending a very different technique to remove objects from the throat. Their suggestion was to reach into the person's throat or slap the person on the face to force the object out. These strategies often had the wrong effect: They lodged the object deeper in the throat instead of forcing it up.

Dr. Heimlich's solution was to apply a force from below. This would push the object out, he reasoned. The technique he recommended uses the lungs as a bellows. The air in the lungs moves quickly up into the windpipe and exerts a force on the object.

Dr. Heimlich's maneuver has saved the lives of more than 100,000 people, including former President Ronald Reagan and actress Elizabeth Taylor. □

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The Heimlich maneuver has saved many lives. But don't try it unless you have proper training.