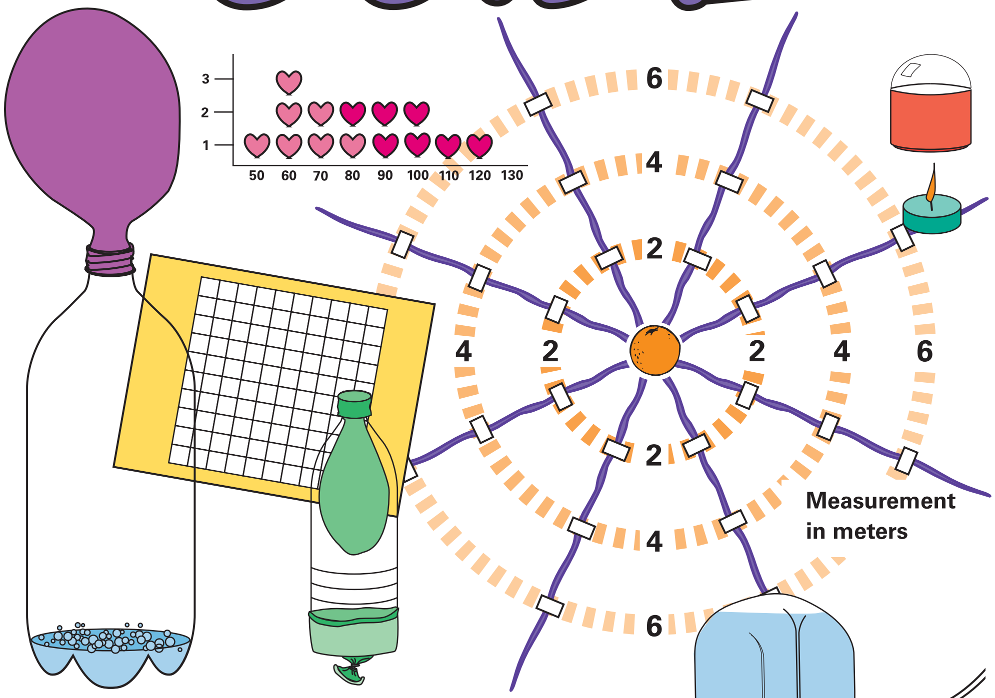
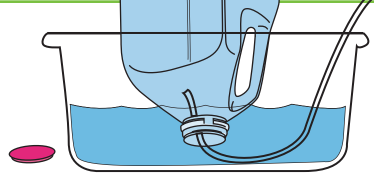
THE SCIENCE OF **Air**

TEACHER'S GUIDE





Written by

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Judith Dresden, M.S.

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Baylor College *of* Medicine

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National Heart, Lung, and Blood Institute, NIH
www.nhlbi.nih.gov

U.S. Environmental Protection Agency
www.epa.gov

Contents

THE SCIENCE OF AIR

The Science of Air Teacher's Guide may be used alone, or integrated with the following Air unit components.

- *Mr. Slaptail's Secret* (illustrated adventure story)
- *Explorations* (student magazine for use in class or at home)
- *The Reading Link* (black-line masters for reading and language arts connections)
- *The Math Link* (black-line masters for mathematics connections)

TEACHER RESOURCES

Downloadable PDF activities and supplemental materials, annotated slide sets for classroom use, streaming video lesson demonstrations, and other useful resources are available free at K8 Science (www.k8science.org).

Where Do I Begin?

WHERE DO I BEGIN?

The Science of Air Teacher's Guide may be used as a stand-alone set of science lessons. However, the other unit components are designed to be used with the guide. To begin the Air unit, some teachers prefer to generate student interest by reading part or all of the student story. Others use the cover of the magazine to build student enthusiasm and introduce the unit. Still others begin with the pre-assessment lesson in the guide.

You may find it helpful to use "The Air Unit Sequence Guide" on the following page to integrate the Air unit components into your schedule. When teaching for 45 to 60 minutes daily, most teachers will complete an entire unit with their students in two to three weeks. If you use the unit every other day or once per week, it will take three to nine weeks to teach, depending on the amount of time spent on each session.

The Science of Air Teacher's Guide provides background information for you, the teacher, at the beginning of each activity. In addition, a listing of required materials, estimates of time needed to conduct activities, and links to other components of the unit are given as aids for planning. Questioning strategies, follow-up activities and appropriate treatments for student-generated data also are included. Student pages are provided in English and in Spanish. The first and final activities in this guide are appropriate for assessing student mastery of concepts.

ABOUT THIS UNIT

The Science of Air activities, explorations and adventures provide students, teachers and parents with science educational materials that are integrated across several subjects of the curriculum. Prepared by teams of educators, scientists and health specialists, this unit focuses on a variety of physical and life science themes. The inquiry-based, discovery-oriented approach of the materials is aligned with National Science Education Standards and National Health Education Standards.

The Science of Air's integrated components help students understand important science, health and environmental concepts related to air.

- ***The Science of Air Teacher's Guide*** provides inquiry-based lessons that entice students to discover concepts in science, mathematics and health through hands-on activities.
- ***Mr. Slaptail's Secret***, the illustrated storybook, presents an engaging mystery adventure, featuring cousins Riff and Rosie, that teaches science and health concepts.
- ***Explorations*** is a colorful magazine full of activities, information, and fun things for children and adults to try in class or at home.
- ***The Reading Link*** provides language arts activities related to the story.
- ***The Math Link*** extends each unit by connecting the story and hands-on science activities to mathematics skill-building and critical thinking exercises.

The Science of Air unit offers flexibility and versatility, and is adaptable to a variety of grade levels and teaching and learning styles.

USING THE UNIT AT THE K-1 LEVEL

The Science of Air unit easily can be adapted for use with younger students. To begin, introduce students to the main characters in the storybook, *Mr. Slaptail's Secret*. Then read the beginning of the story to students. Demonstrate the activity in the back of the storybook and help students do it themselves.

Each story session should cover only about five pages of the book, accompanied by science concepts. The *Explorations* magazine also is an appropriate teaching tool. With very young children, it may be more fitting to conduct some of the activities as teacher demonstrations, unless you have several helpers to assist with the hands-on activities.

Sequence Guide

The Science of Air unit components can be used together in many ways. The chart below may help you coordinate the activities in this guide with the Air unit's student storybook, *Mr. Slaptail's Secret*, and the *Explorations* magazine. Similar information is provided in the "Unit Links" section of each activity in this book.

Additional classroom materials for the Air unit, including *The Math Link* and *The Reading Link* (PDF format), annotated slide sets for classroom use, streaming video lesson demonstrations, and other useful resources are available free at K8 Science (www.k8science.org).

The Science of Air activities are designed to be conducted by students working in collaborative groups. Assign the following roles to group members.

- **Principal Investigator:** Asks others to help, asks questions
- **Materials Manager:** Collects materials, helps the Principal Investigator
- **Recorder:** Writes or draws results, tells teacher when the group is done
- **Safety Scientist:** Follows the safety rules, directs clean-up

ACTIVITY	CONCEPTS	CLASS PERIODS TO COMPLETE	LINKS TO OTHER UNIT COMPONENTS	
			Mr. Slaptail's Secret	*Explorations*
What Is Air?	There are many things to learn about air.	1		
Gases Matter	Air is made up of gases.	1	Story, pp. 1–5 Activity, pp. 32–33	Can We See Air? p. 2
About Air	Air is a mixture of gases.	1	Story, pp. 6–15	It's in the Air, p. 4
Moving Air	Warm air expands.	1	Story, pp. 16–18	Cover activity
Breathing Machine	Air moves in and out of the lungs in response to changes in the size of the chest cavity.	1	Story, pp. 18–26	Breathtaking Fun! p. 4; Where Does the Air Go? p. 8
Lungometer	People have different vital lung capacities.	2	Story, pp. 27–31	Dr. Cindy Jumper, p. 7
Heart and Lungs	The activities of the heart and lungs are linked.	2	Science box, p. 17	Where Does the Air Go? p. 8
Dust Catchers	Dust consists of particles of different substances.	2 or more	Science boxes, pp. 3 and 7	Cover; Not Such a New Issue, p. 5
Fungus Among Us	Fungi spores are present almost everywhere.	1 or more	Science box, p. 20	Let's Talk About Indoor Air, pp. 2–3
There's Something in the Air	Substances in air stay concentrated in enclosed spaces.	1	Science box, p. 24	Tips for Healthy Living, p. 3; We Can Make a Difference! p. 6
Healthy Homes	Summary and post-assessment activity.	2	Science boxes, pp. 28–29	Worldly Words, p. 5

Materials

You will need the following materials and consumable supplies to teach this unit to 24 students working in six cooperative groups. See the Setup section within each activity for alternatives or specifics.

ACTIVITY 2 (p. 5)

2 balloons
1 tsp of baking soda
1/4 cup of vinegar
Note card (or creased sheet of paper)
Soft drink bottle, 2-liter size

ACTIVITY 3 (p. 7)

30 cups of popped popcorn (see Setup for alternatives)
9 clear resealable plastic bags, 1-gal size (12 in. x 15 in.)
6 measuring cups, 8-oz size
Clear plastic bag, 15-gal size (or a bag from the cleaners)
Dry soft drink mix: 2 pkgs of yellow; 1 pkg each of green and red

ACTIVITY 4 (p. 11)

18 clear, wide-mouth plastic cups, 9-oz size
6 crayons or markers, blue
6 crayons or markers, red
6 plastic petri dishes or shallow bowls/saucers
6 prepared aluminum soft drink cans (see Setup)
1 liter of cold water (or ice cubes)
1 liter of room temperature water
1 liter of warm tap water
Dishwashing liquid for bubble solution
Glycerin for bubble solution
Matches, hotplate, warming tray or warm towel
Safety goggles
Tea candle

ACTIVITY 5 (p. 16)

48 balloons, 9-in. round
24 prepared small or medium-sized clear plastic bottles (see Setup)
6 pairs of scissors

ACTIVITY 6 (p. 18)

15 plastic straws, cut in half
6 beakers or marked container, 500–1,000 mL
6 crayons or permanent markers (dark colors)
6 milk jugs with lids, 1-gal size (or container with lid)
6 pieces of plastic tubing, 0.5–2 cm diameter, 45 cm (18 in.) in length
6 plastic tubs, 10-qt size
Self-adhesive notepad, 1-1/2 in. x 2 in.
Water

ACTIVITY 7 (p. 25)

24 pairs of scissors
12 sheets of blue construction paper, 9 in. x 12 in.
12 sheets of red construction paper, 9 in. x 12 in.
6 stopwatches, wristwatches or a classroom clock

ACTIVITY 8 (p. 33)

24 hand lenses (magnifiers)
24 pairs of scissors
24 rubber bands, large (size 84)
24 sheets of marked graph paper, 10 cm x 10 cm
12 sheets of construction paper, 9 in. x 12 in. (see Setup)
6 glue sticks
Baking soda, cornstarch, baby powder or dusty eraser
Cotton balls
Flashlight
Flashlight batteries
Petroleum jelly, 1 lg or 6 sm jars
Roll of wax paper
Microscope (optional)

ACTIVITY 9 (p. 38)

24 clear resealable plastic bags, 4 in. x 6 in. (or small jars or plastic containers)
24 hand lenses (magnifiers) or 6 microscopes
12–13 pieces of old bread baked or brought from home by students
6 pipets or droppers
Black bread mold, *Rhizopus stolonifer* (optional, order from a science educational supply company)
Disposable plastic gloves (optional)

ACTIVITY 10 (p. 45)

48 meters of string or heavy yarn (one 6-meter length per group of 3 students)
3/4-in. roll of masking tape
Marker
Orange
Stopwatch with a second hand, wristwatch or a classroom clock
8 metric tape measures or meter sticks (optional)
Sharp knife (optional)

Safety Issues: Always follow all district and school science laboratory safety procedures. It is good laboratory practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

What Is Air?

1

Pre-assessment

Air surrounds us, yet we rarely think about its composition or why it is important. It is a mixture of colorless, odorless gases, one of which, oxygen, is necessary for functions within cells. Another gas, carbon dioxide, is produced as waste by most living things and also is required for photosynthesis.

Gas molecules are in constant motion. Because heat makes the movement of gas molecules more pronounced, warm air rises and cool air sinks. Many tiny substances can be suspended in air. Some, such as pollen, dust or smoke, can lead to allergies or asthma in some people. Other substances in air, such as chemicals, can be toxic to everyone. Most people think of air pollution as being outdoors. But frequently, pollutants can become more concentrated in indoor environments because of limited fresh air circulation. Fortunately, there are many ways to improve the indoor air quality of homes, schools or offices.

Photo © Giovanni Dall'Orto, Released to Public Domain, Wikimedia Commons.

This unit uses indoor air pollution as a unifying, real-world theme to teach students important physical and life science concepts about gases, air and the respiratory system. It also presents important environmental health concepts related to air quality and indoor spaces.

SETUP

Have students work individually to complete the preassessment.

PROCEDURE

1. Ask students to think about the question, *What questions do you have about air?* Record students' questions on a sheet of chart paper to be displayed in the classroom. Allow opportunities for students to answer their own questions as they complete this unit.
2. Have students complete the pre-assessment individually; then collect and save each student's form. Students will refer back to their pre-assessment answers at the conclusion of this unit.

CONCEPTS

Allows teacher to estimate students' prior knowledge related to air, gases, breathing and respiration, and environmental health.

OVERVIEW

Unit pre-assessment designed for use with students before beginning any unit activities. It will be revisited as part of the Activity 11.

SCIENCE, HEALTH & MATH SKILLS

- Observing
- Recording observations
- Drawing conclusions
- Applying prior knowledge to a new situation

TIME

Preparation: 5 minutes
Class: 30 minutes

MATERIALS

Teacher (see Setup):

- Several sheets of chart paper to record and display student questions

Each student will need:

- Copy of "What Do We Know About Air" page

IMAGE CITATIONS

Source URLs are available at the front of this guide.

PRE-ASSESSMENT ANSWER KEY

1.	d	6.	c
2.	b	7.	b
3.	b	8.	a
4.	c	9.	b
5.	a	10.	c

1 What Do We Know About Air?

Name ______________________________

Please circle the letter beside the correct answer to each question below.

1. Which one of these statements about the air we breath is not true?
   a. Air has pressure.
   b. Air is a mixture of several gases.
   c. Air is made mostly of nitrogen.
   d. The air we take into our lungs is made only of oxygen.

2. What happens to air when it is heated?
   a. It sinks.
   b. It rises.
   c. It turns into rain.
   d. It shrinks.

3. What makes air move into the lungs?
   a. The nose
   b. Changes in the size of the chest cavity
   c. Alveoli (tiny pockets) within the lungs
   d. Movement of the throat

4. The maximum amount of air that can be blown out of the lungs is known as . . .
   a. essential breath volume.
   b. normal air.
   c. vital lung capacity.
   d. breathing rate.

5. What might cause someone to have an allergy attack?
   a. Dust in the air
   b. Not getting enough sleep
   c. Not taking vitamin supplements
   d. Having a bad cold

6. When you exercise . . .
   a. your heart beats faster and your breathing slows down.
   b. your heart beats slower and your breathing speeds up.
   c. your heart beats faster and your breathing speeds up.
   d. your heart beats slower and your breathing slows down.

7. Which of these is not in dust?
   a. Dead insect parts
   b. Gases
   c. Flakes of skin
   d. Food crumbs

8. To which group does mold belong?
   a. Fungus
   b. Plant
   c. Animal
   d. Bacteria

9. Where does fungus grow?
   a. Dark, dry areas
   b. Dark, damp areas
   c. Sunny, dry areas
   d. Sunny, damp areas

10. Which is one way to improve our indoor air?
    a. Install a "dust catcher" air sampler.
    b. Keep the building closed up.
    c. Change air conditioner filters.
    d. Keep bathrooms damp.

¿Que sabemos acerca del aire?

1

Mi Nombre ____

Favor de poner un círculo alrededor de la letra junta a cada respuesta correcta.

1. ¿Que declaración acerca del aire es falsa?
   a. El aire tiene presión.
   b. El aire es una mezcla de varios gases.
   c. El mayor componente del aire es el nitrógeno.
   d. El aire que inhalamos se compone exclusivamente del oxígeno.

2. ¿Que pasa cuando el aire se calienta?
   a. Se va para arriba.
   b. Se va para abajo.
   c. Se convierte en lluvia.
   d. Se contrae.

3. ¿Que hace que el aire se mueve en los pulmones?
   a. La nariz
   b. Los cambios en el tamaño de la cavidad de pecho
   c. Los alvéolos (bolsitas) dentro de los pulmones
   d. Los movimientos de la garganta

4. La cantidad máxima del aire que se puede vaciar de los pulmones se conoce como . . .
   a. el volumen esencial de respiración.
   b. el aire normal.
   c. la capacidad vital pulmonar.
   d. la tasa de respiración.

5. ¿Que prodría provocar un ataque de alergia?
   a. Polvo en el aire
   b. No dormir suficiente
   c. No tomar vitaminas
   d. Estar acatarrado

6. Cuando haces ejercicio . . .
   a. tu corazon late más rapidamente y tu respiración es más lenta.
   b. tu corazon late más lentamente y tu respiración es más rápida.
   c. tu corazon late más rapidamente y tu respiración es más rápida.
   d. tu corazon late más lentamente y tu respiración es más lenta.

7. ¿Cual de los siguientes no se encuentra en el polvo?
   a. Unos pedazos de insectos muertos
   b. Algunos gases
   c. Unas escamas de la piel
   d. Algunas migas del alimento

8. ¿A cual grupo pertence el moho?
   a. Los hongos
   b. Las plantas
   c. Los animales
   d. Las bacterias

9. ¿Donde crece el moho?
   a. Los lugares oscuros y secos
   b. Los lugares oscuros e húmedos
   c. Los lugares asoleados y secos
   d. Los lugares asoleados e húmedos

10. ¿Cual de las siguientes acciones puede ayudar a mejorar la calidad del aire adentro de los edificios?
   a. Instalar un "atrapapolvos" para tomar muestras del aire.
   b. Mantener cerrado el edificio.
   c. Cambiar los filtros del acondicionador del aire.
   d. Mantener húmedos los baños.

The Air Around Us

Physical Science Basics

WHAT IS OZONE?

Ozone is a molecule composed of three atoms of oxygen. Two oxygen atoms form the basic oxygen molecule—the oxygen we breathe that is essential to life. The third oxygen atom in ozone can detach from the molecule and re-attach to molecules of other substances, thereby altering their chemical composition.

Ozone in the upper atmosphere helps filter out damaging UV radiation from the sun. However, ozone in the lower atmosphere—the air we breathe—can be harmful to the respiratory system.

Ozone generators sold as air cleaners disburse ozone into the surrounding room/environment. No agency of the federal government has approved these devices for use in occupied spaces because ozone at high concentrations can cause health problems, and because scientific evidence shows that ozone generators do not remove contaminants or particles from the air.

Source: EPA, www.epa.gov

Even though we normally can't see it or smell it, the air that surrounds us is a chemical substance comprised of several different colorless and odorless gases (mostly nitrogen and oxygen). As in all gases, the molecules in air are distributed more or less evenly throughout any space in which they are found. When we breathe, all of the different gases in air enter and leave our lungs.

There is a lot of empty space around the molecules in gases, such as air, because they are packed much more loosely than the molecules in liquids or solids. For example, oxygen gas is about 1,000 times less dense than liquid oxygen. As anyone who has inflated a tire knows, air can be compressed, and the air inside a tire is more dense than air outside. Air also is heavy. At lower altitudes, one cubic meter of air has a mass of one kilogram.

Other gases, produced as a result of human activities, mix easily with the gases in air. Thus, the air we breathe may contain trace amounts of many different kinds of molecules.

At times, we are able to feel air currents, such as wind or the air rushing out of a balloon. Air, like any gas, will move from an area with higher pressure and density (inside the balloon) to an area with lower pressure and density (outside the balloon). Changes in temperature also will cause movement of air and other gases. In general, warmer air will rise and cooler air will sink. Movement of air masses of different temperatures is the driving force behind air currents and winds.

The atmosphere contains various types of particles, created through both natural and man-made processes. The largest particles are about the size of a grain of sand (0.5 millimeters in diameter). Some particles actually are tiny droplets of liquids, like the water particles that make up fog or mist. Others are solids. Smoke, for example, contains very tiny solid particles produced by the incomplete burning of fuel. Living organisms also contribute particles to the air. Pollen grains, mold and bacterial spores, viruses and animal dander (tiny flakes of skin) all are sources of atmospheric particles.

COMPONENTS OF DRY AIR

- Nitrogen gas (N_2) 78%
- Oxygen gas (O_2) 20%
- Argon 0.9%
- Carbon dioxide (CO_2) 0.03%
- Minute amounts of:
  - Neon
  - Krypton
  - Helium
  - Xenon
- Other substances, including pollutants

Atmospheric air may contain 0.1% to 5% water vapor (H_2O) by volume.

Gases Matter

2

Physical Science

This activity provides a basic introduction to the concept of gases. If your students already have explored gases, you may wish to use this activity as a review or skip to Activity 3, “About Air.”

Gases are one of the three basic states of matter (the other two are liquids and solids). Unlike liquids or solids, gases will expand indefinitely if they are not in a container. Even though we cannot see or smell many gases, it is possible to observe them in other ways. For example, it is relatively easy to detect the pressure exerted by a gas on the walls of a balloon or an inflatable tire.

The air we breathe is a mixture of several gases. One of these, carbon dioxide, is produced as a waste product by most living cells. Carbon dioxide also can be produced by a number of other means, including the mixing of a weak acid (vinegar) with sodium bicarbonate (baking soda).

Unit Links

Mr. Slaptail’s Secret
Story, pp. 1–5;
Activity, pp. 32–33

Explorations
Can We See Air? p. 2

SAFETY

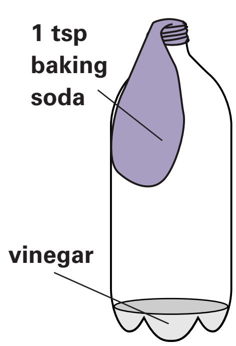
Always follow district and school science laboratory safety procedures. It is good practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

SETUP

Place a clear soft drink bottle, a balloon, baking soda and a container of vinegar in the area you usually use for demonstrations. Conduct this activity as a discovery lesson with the entire class.

PROCEDURE

1. In front of your students, inflate a large balloon. Ask them if there is anything inside the balloon. Stimulate a discussion about the contents of the balloon, leading them to the conclusion that the balloon contains air.
2. Tell students, “Air consists of gases we cannot see or smell. However, we can tell gases are present in the balloon because they place pressure on the sides of the balloon and make it expand.” Let the students feel the sides of the balloon.
3. Ask the students to observe as you place a few tablespoons of vinegar into the soft drink bottle. Next, using a note card that



Continued

CONCEPTS
- Gases take up space.
- Carbon dioxide is a gas.

OVERVIEW
This activity is a general introduction to gases for students who have not yet learned about the states of matter. It also can be presented as a review.

SCIENCE, HEALTH & MATH SKILLS
- Observing
- Drawing conclusions

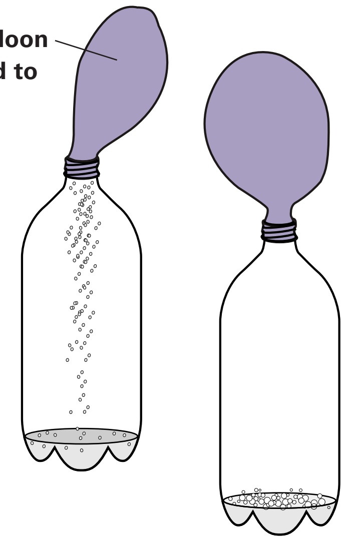
TIME
Preparation: 10 minutes
Class: 20 minutes

MATERIALS
Teacher (see Setup):
- 2 balloons
- 1 tsp of baking soda
- 1/4 cup of vinegar
- Note card or creased sheet of paper
- Soft drink bottle, 2-liter size

TRY THIS!
Inflate a balloon to its full size. Keep the mouthpiece pinched closed with your fingers. Let a tiny amount of air escape from the balloon. Can you feel the movement of the gas? You might even be able to hear it.

you have creased down the center, slide about one teaspoonful of baking soda inside the second balloon. Fasten the balloon over the mouth of the bottle, without letting the baking soda fall into the bottle.

4. Gently lift the balloon upward and let the baking soda fall into the vinegar at the bottom of the bottle. As carbon dioxide is produced inside the bottle, the balloon gradually will inflate. Challenge students to think about what might be causing the balloon to expand. Lead them to understand that mixing the two compounds produced a gas, known as carbon dioxide, which also is released from our bodies when we breathe out.



VARIATIONS

- Small groups of students may enjoy mixing the compounds themselves to produce carbon dioxide. When conducted by students, this activity will take about 30 minutes to complete. Materials needed to conduct a class activity with six student groups are: 6 soft drink bottles, 12 balloons, 1-1/2 cups of vinegar, 6 teaspoons of baking soda and 6 note cards.
- To demonstrate how living organisms release carbon dioxide when they use food for energy to grow and reproduce, place one tablespoon of dry yeast, one teaspoon of sugar, and 1/4 cup of warm water in a soft drink bottle. Mix by gently swirling the bottle. Attach a balloon to the top of the bottle, and set the bottle aside for about 30 minutes. The balloon will begin to swell as the yeast cells become active, use the sugar for food, and release carbon dioxide.
- Have the students make the cylinder flyer described in the story, *Mr. Slaptail's Secret.* (Directions for creating the flyer are given at the end of the book.) Talk about what might be holding the flyers up as they soar through the air.

SOLID TO GAS

When heated, most solids become liquids before changing into gases. The molecules of some substances, however, move directly from a solid state into a gas. This process can be observed with solid carbon dioxide, also known as dry ice. The cloud of carbon dioxide gas released from solid dry ice at normal room temperature and pressure has been used as a theatrical special effect for many years.

TEACHER RESOURCES

Downloadable activities in PDF format, annotated slide sets for classroom use, streaming video lesson demonstrations, and other resources are available free at www.k8science.org and www.bioedonline.org/.

About Air

Physical Science

About 78% of the volume of dry air is nitrogen gas (N_2). Oxygen (O_2), the component of air required by our bodies, comprises less than one fourth of dry air. Argon, a non-reactive gas, makes up slightly less than 1% of dry air. Carbon dioxide (CO_2), a gas released from our bodies when we exhale, is present in even smaller quantities (less than one part per 1,000). Very minute amounts of many other naturally-occurring gases (such as neon, helium, methane and ammonia), as well as gases resulting from pollution, are present in air. Water vapor, when present, can occupy up to 5% of the total volume of air. When we breathe, nitrogen, oxygen and all the other components of air enter and exit our lungs.

Unit Links

Mr. Slaptail's Secret
Story, pp. 6–15

Explorations
It's in the Air, p. 4

CONCEPTS

- Gases occupy space.
- Air is a mixture of different gases.
- Oxygen, a gas needed by the human body, is not the principal component of air.

OVERVIEW

Students will use different colors of popcorn to model the composition of air.

SCIENCE, HEALTH & MATH SKILLS

- Measuring
- Observing

TIME

Preparation: 10 minutes
Class: 20 minutes

MATERIALS

Teacher (see Setup):

- 30 cups of popped popcorn (see Setup for alternatives)
- 3 clear resealable plastic bags, 1-gal size (12 in. x 15 in.)
- Clear plastic bag, 15-gal size (or a bag from the cleaners)
- Dry soft drink mix: 2 pkgs of yellow, 1 pkg each of green and red
- Transparency of "Let's Measure" student sheet

Each group will need:

- Clear resealable plastic bag, 1-gal size (12 in. x 15 in.)
- Measuring cup, 8-oz size
- Copy of "Let's Measure" student sheet

SAFETY

Always follow district and school science laboratory safety procedures. It is good practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

SETUP

You will need to pop and tint three small batches of popcorn before you begin this activity. First, pop the corn. To tint it, measure 6 cups of popcorn into a sealable plastic bag. Add a tablespoon of yellow soft drink mix and 1–3 teaspoonfuls of water. Seal the bag and shake to distribute the color. Repeat the tinting process with the red, and again with the green mix—but use only 1 cup of white popcorn with each of these colors. Ultimately, you should have 6 cups of yellow popcorn in the first bag, 1 cup of red popcorn in the second bag, and 1 cup of green popcorn in the third bag. Let the popcorn dry by spreading it on a paper towel or leaving the bags open.

When dry, put each color of popcorn in separate containers. You also will need about 22 cups of white popped corn.

As an alternative, you may use purchased popcorn. Select different flavors to represent three colors. You also can use different colored styrofoam packing peanuts or small balls of crumpled paper in different colors.

If you would like to create a larger model of air, multiply the materials by two or more.

PROCEDURE

1. Divide the students into six small groups. (If your students

Continued

are very young, you may prefer to conduct the activity as a discovery lesson with the entire class.)

2. Have the Materials Manager from each group collect a measuring cup and a sealable plastic bag. Give three groups approximately 7 cups of white popcorn each. Give 1 bag of colored popcorn to each of the remaining three groups.
3. Project a transparency of the "Let's Measure" student sheet while you explain that each group with white popcorn will measure 5 cups of popcorn into its bag; the group with yellow popcorn will measure 4 cups; the group with red popcorn will measure 1/4 cup; and the group with green popcorn will place only one kernel in its bag.
4. When the students have finished measuring, ask one student from each group to empty the popcorn from the group's bag into the large, clear plastic bag (which you will hold in a central location).
5. Shake the large plastic bag. Ask, *What do you think I'm doing?* Lead the students to understand that the popcorn is being mixed. Ask, *Are the colors of popcorn arranged in a special way in the bag?* Students should note that the colors are mixed randomly.
6. Have the students identify which color of popcorn is represented by the most kernels in the bag, by the second-most kernels and so on, until you mention the single kernel of green popcorn. Follow by asking students to name other kinds of mixtures (e.g., fruit salad, crayons of different colors in a container, etc.).
7. Explain that air also is a mixture, made up of different kinds of gases. The different colors of popcorn in the large bag are present in the same proportions as the different gases in air. (Some students already will know that oxygen and carbon dioxide are involved in breathing. If the class is not familiar with this information, point out that the gas we take out of air when we breathe in is known as oxygen, and the gas we release when we breathe out is carbon dioxide.) Ask students to guess which color of popcorn represents oxygen molecules (yellow) and carbon dioxide molecules (green) in air.
8. Finally, point out that air is mostly nitrogen, represented by the white popcorn. The red popcorn corresponds to argon, gases present in air, but not absorbed by the body during breathing.

VARIATIONS

- Make your own colored and flavored popcorn using the "Fiesta Popcorn" recipe (left sidebar).

FIESTA POPCORN

8 cups of popped popcorn

1/4 cup of sugar

6 tbs of butter

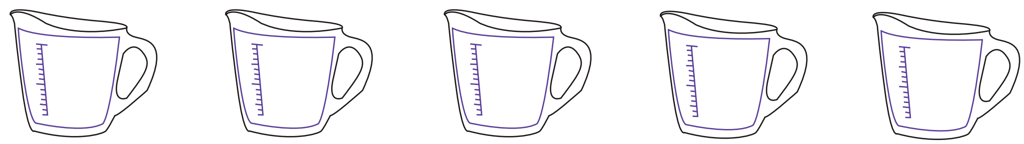
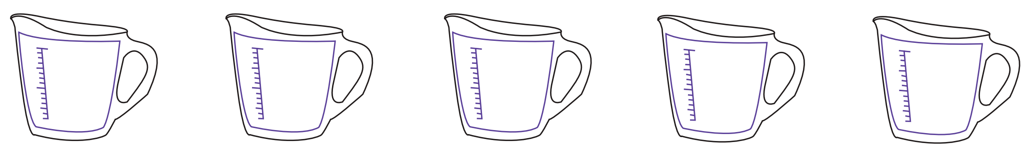
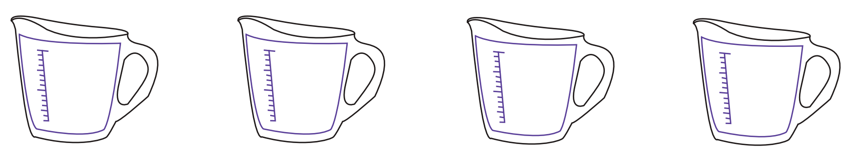
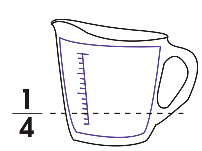
3 tbs of light corn syrup

1/4 tsp of baking soda

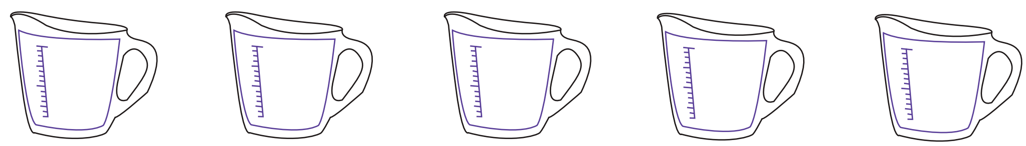
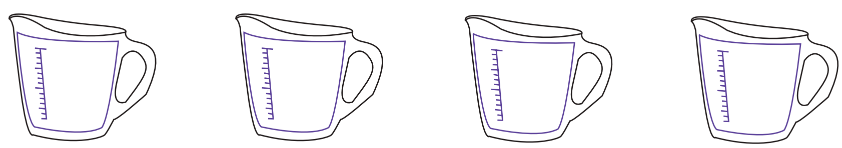
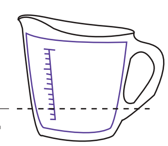
Food coloring

In a 2-quart saucepan, combine sugar, butter and corn syrup. Cook and stir over medium heat until mixture comes to a boil. Cook without stirring for 5 minutes. Remove from heat and stir in baking soda and food coloring. (If more than one color is desired, separate mixture into containers before adding food coloring.) Pour mixture over popcorn and stir gently to coat. Bake in a 300°F oven for 15 minutes. Stir, and then bake for 10 more minutes. Place popcorn in a large bowl to cool.

Let’s Measure

Color of Popcorn	Cups of Popcorn
White	
White	
White	
Yellow	
Red	
Green	

Vamos a Medir

Color de las Palomitas	Tazas de Palomitas
Blancas	
Blancas	
Blancas	
Amarillas	
Rojas	
Verde	

Moving Air

Physical Science

The molecules in air (and in all gases) are constantly moving, but the amount of movement depends on temperature. At higher temperatures, molecules are more active. They bounce off one another and off the sides of a container with more energy. At lower temperatures, molecules move less and bounce with less energy. A given number of gas molecules will take up more space when warm (because of more energetic "bouncing") than the same number of molecules at a lower temperature. These characteristics account for much of the air movement that we can observe, both indoors and outdoors. Air currents develop when there are differences in temperatures, because higher-energy ("bouncier") warm air molecules rise and lower-energy cool air molecules sink. In this activity, students will observe that warm air pushes more against the sides of a bubble than cold air does.

Unit Links

Mr. Slaptail's Secret
Story, pp. 16–18

Explorations
Cover activity

SAFETY

Have students wear protective safety goggles. Always follow district and school science safety procedures. It is good practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

SETUP

This activity uses aluminum soft drink cans that you have trimmed prior to class. Cut each can approximately in half (scissors work well) and save the bottom section. You will need one bottom section per group of students. (Discard or recycle the top halves.) Make sure that the cut edges of the cans are relatively smooth OR cover the edges with tape.

You also will need to prepare "bubble solution" if you do not have any available. To make one gallon of "bubble solution," which will keep indefinitely, mix together one gallon of water, one cup of "Ivory" or "Dawn" dishwashing liquid and 1/4 cup of glycerin (from the drugstore).

PROCEDURE

1. Challenge your students to predict whether warm air and cold air behave differently. Ask, *Do you think air will sink or rise if it is warmed?* Write students' predictions on the board or have each group make its own prediction.
2. Set up a station from which the Materials Managers can pick

Continued

CONCEPTS

Heat causes the molecules in air to become more active and push harder against the sides of a container.

OVERVIEW

Students will observe how the warming or cooling of a small amount of air changes the amount of space that it can occupy inside a bubble.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Observing
- Drawing conclusions

TIME

Preparation: 30–45 minutes
Class: 30–45 minutes

MATERIALS

Teacher (see Setup):

- 1 liter of cold water (or ice cubes)
- 1 liter of warm tap water
- 1 liter of room temperature water
- 1 tea candle and matches, hotplate, warming tray or warm towel
- Dishwashing liquid and glycerin for bubble solution

Each group will need:

- 3 clear, wide-mouth plastic cups, 9-oz size
- Prepared bottom half of an aluminum soft drink can
- Crayon or marker, blue
- Crayon or marker, red
- Plastic petri dish or shallow bowl/saucer
- Copy of "My Observations" student sheet

Each student will need:

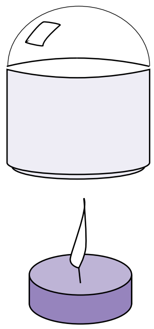
- Safety goggles

up the following supplies for their groups: one prepared can, one shallow dish or bowl with bubble solution, one cup half-filled with warm tap water, one cup half-filled with ice water (include a few ice cubes), and one cup half-filled with room temperature water.

3. Demonstrate how to tip the open end of a can in the bubble solution to create a thin film. Have students predict what might happen to bubble film when the can is placed in room temperature, warm and cold water. They should draw their predictions on their student sheets. Have students dip the open ends of their cans into bubble solution. A film of solution will be visible across the top of the can. Direct each group to place its can in one of the cups (cold water, warm water or room temperature water). Let students observe the bubble film for about a minute. Ask, *What is happening to the bubble? What does this tell us about the air inside the can?*
4. Have students record their observations on the "My Observations" sheet. Then have each group make a new bubble film and place its can in one of the other cups. Have students record their results before placing and observing the can in the third cup.
5. Discuss students' predictions about the behavior of warm and cool air, in light of their observations. Ask, *What do you think will happen if we heat the air in the can even more?* In a demonstration area, dip another can in bubble solution; then heat it using a lighted candle, hotplate, warm towel, etc. (The bubble will bulge much more dramatically than students saw in their previous trials.)
6. Discuss the students' discoveries about air movement and encourage them to think about what might be happening with the air inside the classroom. Ask, *What happened to the air inside the can when it was placed in cold water? In warm water?* Follow by encouraging a general discussion. Ask, *Where are the sources of different air temperatures in the room? What will happen if the air in one part of the room is warmer than air in other parts?*

VARIATIONS

- Let students use bubbles to study air movements in other ways. For example, have them gently blow bubbles up into the air. Have them observe where the bubbles travel. Ask, *Do the bubbles eventually fill the room? Do they move upward or downward?* (An inexpensive bubble blower can be made by removing the bottom from a paper cup.)



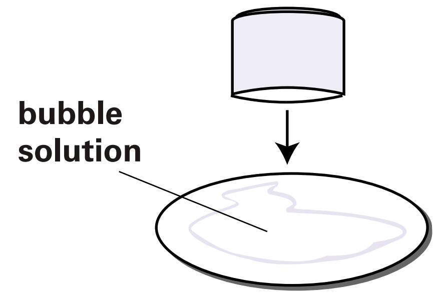
For a demonstration, dip a can in bubble solution, and then hold it over a heat source. The results will be more dramatic than those achieved when using warm water.

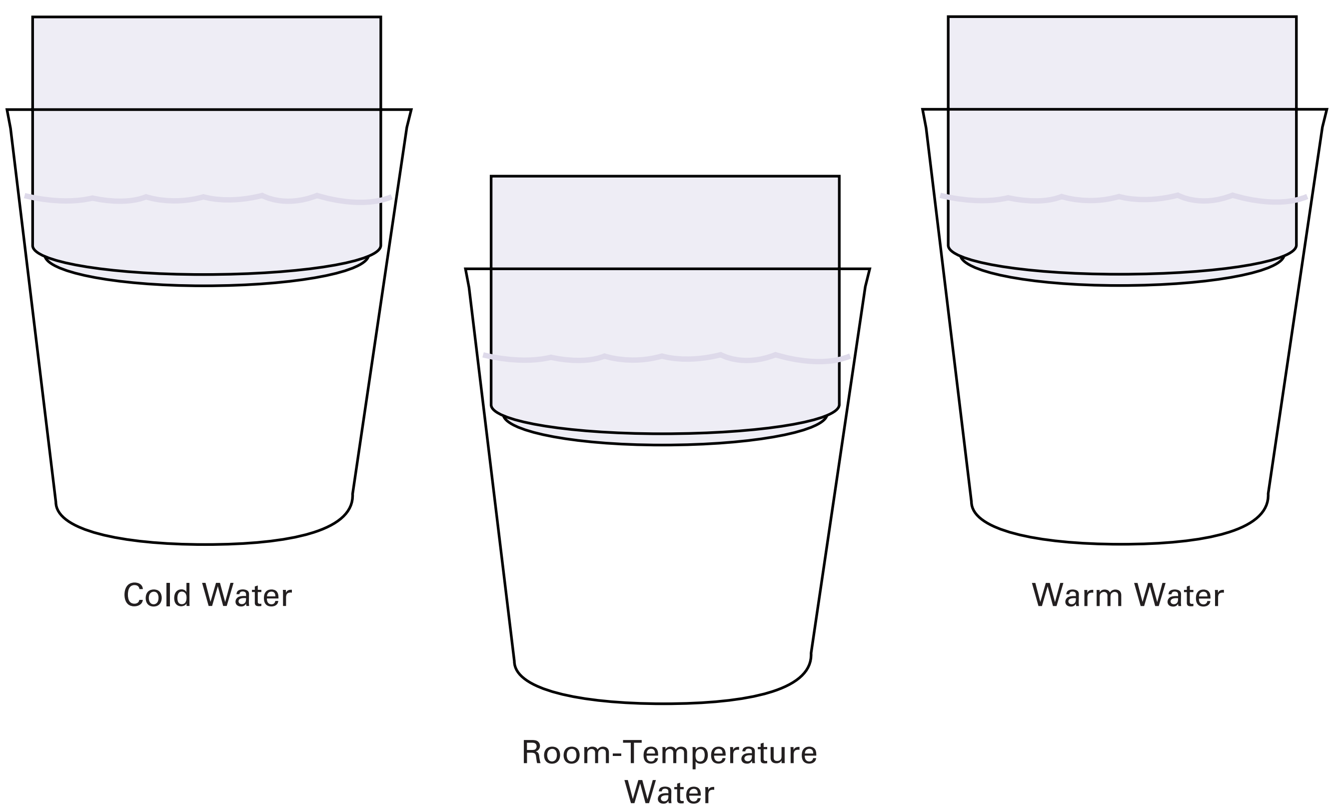
QUESTIONS FOR STUDENTS TO THINK ABOUT

- Have students predict how the air movement caused by temperature differences will affect the distribution of dust and other pollutants within a room or building. (Also see Activity 9, "Fungus Among Us.")
- Have students look at a map or globe. The sun heats air near the equator much more than it heats air near the poles. (Because the poles receive less direct heat from the sun.) Ask, *How do you think these temperature differences affect air movement on Earth?* Have students compare their predictions to wind patterns shown on a weather chart.

My Observations

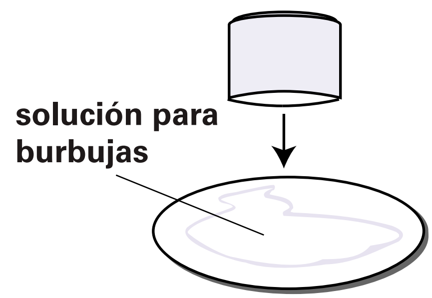
1. **Prediction:** Draw a red line that shows how high you think the bubble will be after each trial.
2. Dip the can in bubble solution to make a thin film across the top.
3. Place the can in one of the cups of water and observe what happens.
4. Draw a blue line showing what the bubble looked like.
5. Repeat for the other two cups of water.

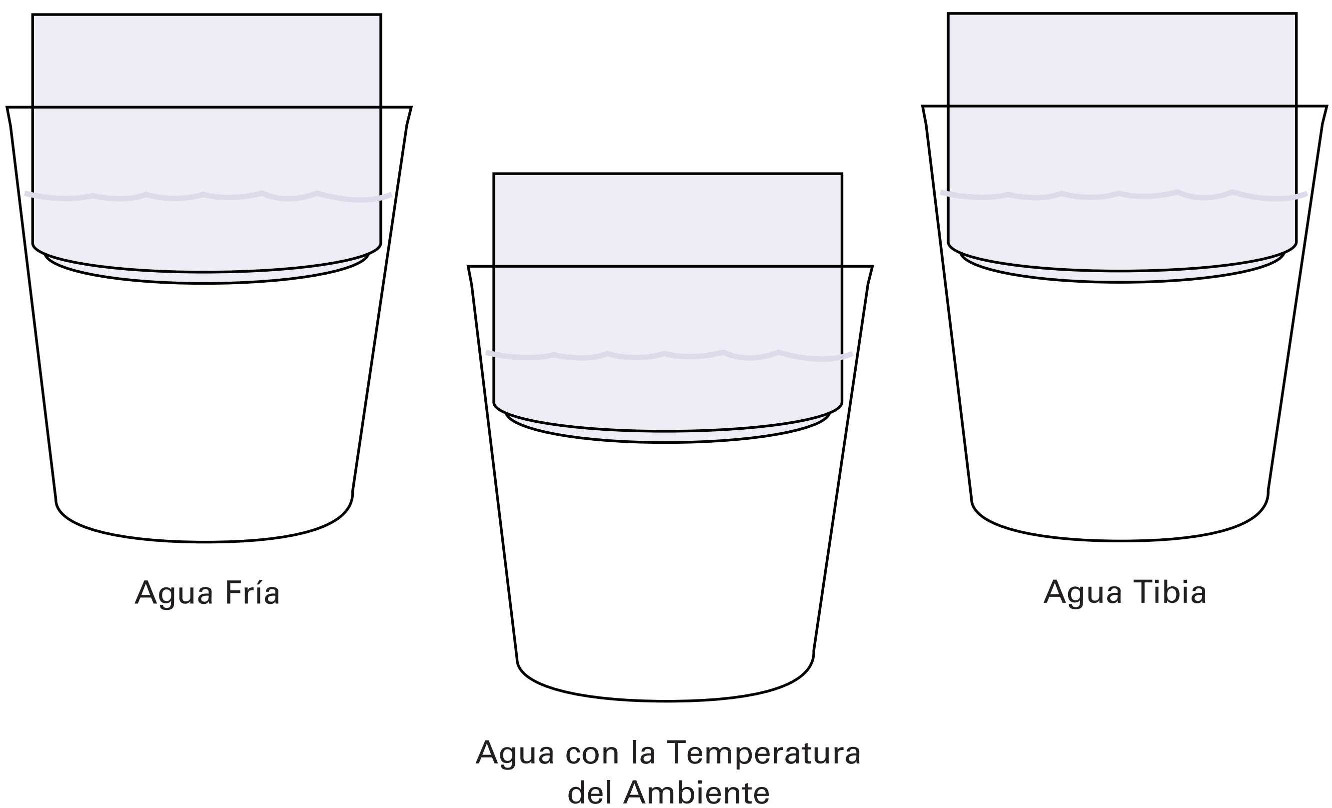




Mis Observaciones

1. **Predicción:** Dibuja una línea roja que señala donde piensas que va a quedar la burbuja en cada uno de los tratamientos.
2. Vierte el bote en la solución para hacer burbujas.
3. Pon la base del bote en una de las tazas de agua y observa lo que pasa.
4. Dibuja una línea azul para señalar donde quedó la burbuja.
5. Repetir para las otras dos tazas.





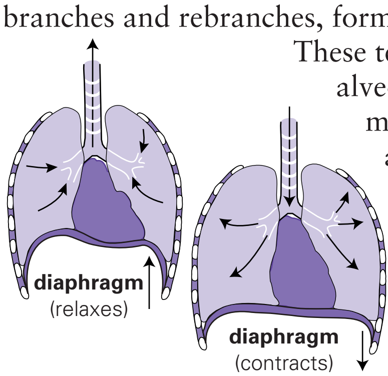
Breathing

Life Science Basics

The cells in our bodies require oxygen to complete the reactions that allow energy to be released from food. The process through which these reactions occur, known as aerobic (from *aeros* for air) respiration, produces carbon dioxide as a waste product.

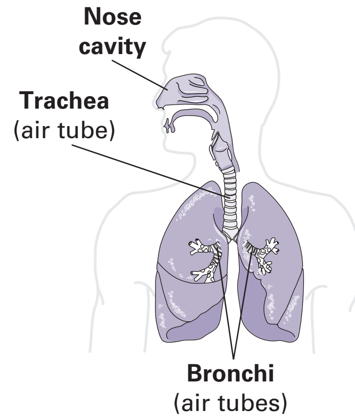
Many large organisms have developed systems to supply cells with oxygen and eliminate carbon dioxide from the body. Fish gills, for example, draw water across thin membranes, thus allowing dissolved oxygen to be transferred into the bloodstream. Insects have a network of small tubes that branch throughout the body and carry air directly to individual cells. Most other land animals use lungs and a blood transport (circulatory) system to take in oxygen and transport it throughout the body, while simultaneously removing carbon dioxide.

The human respiratory system is similar to that of all other mammals. Air enters the nose, where it is warmed and filtered. It passes through the pharynx at the back of the throat and enters the larynx (also called the Adam's apple), or voice box. From there, it passes through the trachea into the chest cavity. The trachea branches into two tubes (plural, bronchi; singular, bronchus), each leading to one of the lungs. Each bronchus branches and rebranches, forming smaller and smaller ducts. These terminate in tiny pockets, called alveoli, which are surrounded by minute blood vessels. Within the alveoli, oxygen moves into the blood stream and carbon dioxide diffuses out.

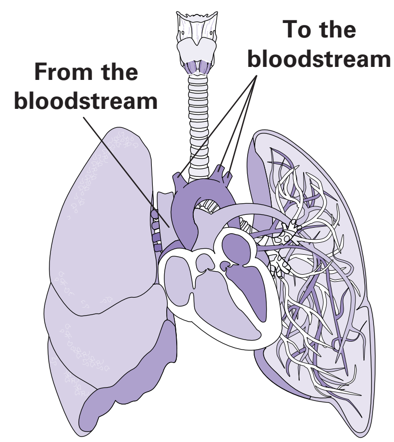


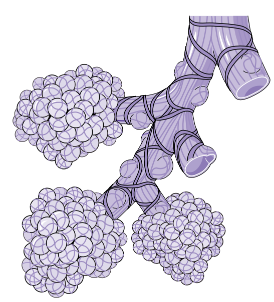
Breathing, the actual process of drawing in and expelling air, is a partially passive process controlled by changes in the volume of the chest cavity. The work of breathing is accomplished by muscles in the walls of the chest and in the diaphragm, a thin layer of muscle at the base of the chest cavity. When these muscles tighten, they increase the size of the space inside the chest. This causes air to rush into the lungs. When the muscles relax, the space becomes smaller and air moves out of the lungs.

When we breathe, all components of air (including pollutants) are drawn into the lungs. Some harmful substances can be expelled from the body by coughing or sneezing. Others are trapped and eliminated in mucus. A few, however, remain in the lungs, where they can cause permanent irritation or damage. Some chemicals in air even are absorbed into the bloodstream through the lungs and are transported to other parts of the body.



Air enters the body through the nose and mouth. When it reaches the lungs, some oxygen is taken into the bloodstream, and carbon dioxide, a waste product, is released.





If you spread out all the tiny pockets in the lungs, they would cover an area the size of a tennis court.

5 Breathing Machine

Life Science

CONCEPTS

Air moves in and out of the lungs in response to volume changes in the chest cavity.

OVERVIEW

Students will create a model that approximates how the lungs, chest and diaphragm interact during breathing.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Observing
- Modeling
- Drawing conclusions

TIME

Preparation: 20 minutes
Class: 30–45 minutes

MATERIALS

Teacher (see Setup):

- Half-liter water bottles (12 for groups of 2; 6 for groups of 4)
- Clear plastic packaging tape

Each group or student will need:

- 2 balloons, 9-in. round
- Pair of scissors
- Prepared bottle

Each of us breathes about eight to ten times per minute. When we exercise, the rate increases to 15 to 20 times per minute. Surprisingly, our lungs have no muscles of their own. How, then, is the work of breathing done?

The diaphragm and rib muscles of the chest wall work for the lungs. By changing the size of the chest cavity, these muscles control whether air enters or exits the lungs.

Unit Links

Mr. Slaptail's Secret
Story, pp. 18–26

Explorations
Breathtaking Fun! p. 4; Where Does the Air Go? p. 8

The diaphragm, a broad, thin muscle that stretches across the body between the chest and the abdomen, is responsible for about 75% of the air flow in breathing. At rest, the diaphragm actually bulges upward. When we are about to take a breath of air or inhale, the diaphragm moves downward, thereby increasing the space available (and decreasing total pressure) within the chest. The rib muscles move upward and outward at the same time, increasing the space available for air flow by another 25%. Outside air rushes in to fill this space.

Breathing out, or exhaling, is normally a passive process. As the muscles of the chest and diaphragm relax, the space inside the chest becomes smaller and air moves out of the lungs. When we exhale forcibly, some of these muscles actively help push the air out.

SAFETY

Always follow district and school science laboratory safety procedures. It is good practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

SETUP

This investigation works best with groups of two to four students, with each group making one "breathing machine." (As an alternative, have each student create his or her own breathing machine.)

One or more days before beginning this activity, ask each group to bring a small to medium-sized clear plastic bottle from home (half-liter water or soft drink bottle, or liquid dishwashing detergent bottle). Cut off and discard the bottom third of each bottle. The remaining top part of the bottle should be about six inches (15 cm) tall. Cover sharp edges with clear plastic packaging tape.

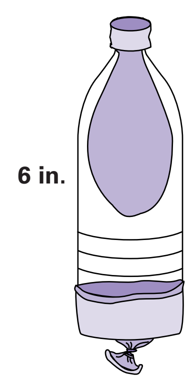


Illustration by M.S. Young © Baylor College of Medicine

Continued

Note. Liter-size soft drink bottles are too large to work effectively in this activity.

PROCEDURE

1. Begin by asking each student to notice his or her own breathing. Ask, *How many times are you breathing per minute? How can you tell? Which parts of your body move when you breathe?* Tell students that they will make a simple model to investigate how air moves in and out of the body.
2. Have the Materials Managers pick up prepared plastic bottles and balloons for their groups.
3. One student from each group should slide a balloon into the top of the bottle and roll the open end (mouth) of the balloon over the top edge of the bottle (see illustration, p. 16).
4. Another student should cut off the bottom of the second bal loon and tie a knot in the stem (mouth) of the remaining piece. While one student holds the bottle, another should slide the cut end of the balloon around the cut end of the bottle.
5. Ask students to predict what might happen when the bottom balloon is pulled downward. Have students try pulling the bottom balloon gently. Ask, *What happened to the top balloon?* Point out that this is similar to what happens when each of us breathes in.
6. Next, direct the students to squeeze the sides of the bottle gently while pushing the bottom balloon into the space in the bottle. Ask, *What happened?*
7. Using the diagram on page 8 of the Air unit's *Explorations* magazine, help students understand that the balloon inside the model represents our lungs and that the bottom balloon represents our diaphragm. Discuss ways in which their models are similar to and different from the actual respiratory system.
8. Have students stand and take a deep breath. They should be able to notice that their chests expand when they inhale and contract when they exhale.

VARIATIONS

- Challenge your students to make their lung models "cough" or "sneeze." For a more dramatic effect, place 1/2 teaspoon of baking soda or baby powder inside the balloon "lung" before making the model "cough" or "sneeze."

  Safety Note: Be aware of risks to students with respiratory illnesses, such as asthma.
- You may prefer to have students make their breathing machines at home with a family member or friend (see this unit's *Explorations,* p. 4).
- Try making a more accurate model by filling the inside of the breathing machine with water.

ABOUT THE MODEL

The breathing machine model shows students how changes in pressure draw air into the lungs. However, there are several differences between real lungs and the model.

- Humans have two lungs.
- Lungs actually fill the entire space available within the chest.
- Each lung has a spongy appearance inside, instead of being hollow.
- The thin space between the lungs and the chest wall is filled with liquid.
- The chest cavity itself is divided into two spaces, one for each lung.

QUESTIONS FOR STUDENTS TO THINK ABOUT

Tell students that when we breathe in, oxygen is removed from the air in our lungs and carbon dioxide is released. Ask, *What happens to the other things in air when we breathe in? Do we breathe nitrogen and other gases in and out? What about harmful things in air? Do we also breathe them in?*

6

Lungometer

Life Science

CONCEPTS

- Air takes up space.
- The lungs hold air.
- Air travels in and out of the lungs.
- People differ in the amount of air that they can blow out of their lungs.

OVERVIEW

Students will investigate their own vital lung capacities — the amount of air that can be forced out of the lungs in a single breath.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Observing
- Measuring
- Graphing

TIME

Preparation: 10–20 minutes
Class: one session of 30–45 minutes to build and use lungometers; one session of 30–45 minutes to examine results

MATERIALS

Each group will need:

- Beaker or marked container, 500–1,000 mL
- Crayon or permanent marker (dark colors)
- Milk jug with lid, 1-gal size
- Piece of plastic tubing, 0.5–2 cm diameter, 45 cm in length (18 in.)
- Plastic tub, 10-qt size
- Self-adhesive notepad, 1-1/2 in. x 2 in.
- Water
- Copy of "Make a Lungometer" student sheet

Each student will need:

- Prepared mouthpiece
- Copy of "Lungometer Data Sheet"

When we breathe inward (inhale), air from outside enters our airways and lungs. As demonstrated in the activity, "Breathing Machine," breathing is a mechanical process, driven by changes in the volume of the chest cavity. The air taken in with a normal breath represents only part of the total amount of air the lungs can hold. Likewise, the amount of air normally breathed outward (exhaled) represents just a portion of the total amount of air that can be expelled.

The maximum amount of air that can be blown out of the lungs after taking a deep breath is known as vital lung capacity. But some air always remains in the lungs and airways.

Diseases of the respiratory system affect lung volumes and capacities in many different ways. Some diseases reduce the lungs' vital capacity. Others cause changes in the amount of air held in the lungs after air is blown out forcefully.

Unit Links

Mr. Slaptail's Secret
Story, pp. 27–31

Explorations
Dr. Cindy Jumper, p. 7

SAFETY

Students with asthma or other breathing problems should not measure their vital lung capacities.

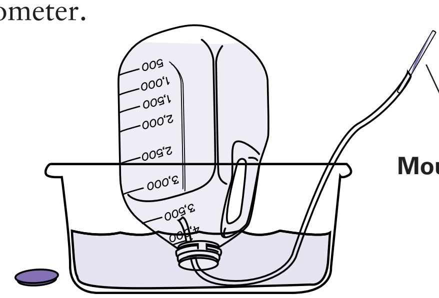
Each student will need his or her own mouthpiece (see Setup). Tubing also may be washed with antibacterial soap or soaked in a mild bleach solution. Wash tubing before storing.

Always follow district and school science laboratory safety procedures. It is good practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

SETUP

Cut plastic drinking straws in half to serve as mouthpieces. Each student will use his or her own clean mouthpiece, inserted into the plastic tubing of the lungometer.

This activity requires two class periods and is appropriate for students to carry out in small groups. Students should rotate jobs, so that each participant has an opportunity to measure his or her vital lung capacity.

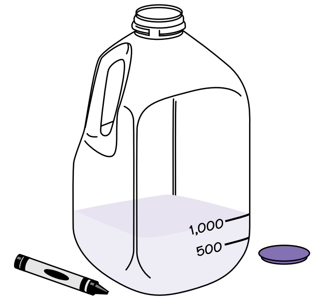


Most students will find it helpful to see a lungometer that you have

Continued

constructed (see “Make a Lungometer,” p. 21) before they attempt to make one themselves.

Alternatively, you may conduct the activity as a demonstration, or let each student measure his or her vital lung capacity on a lungometer that you have made.



The vital lung capacity of elementary school children often falls between 1,300 and 2,300 mL.

PROCEDURE

Session 1: Making lungometers

1. Make a lungometer and demonstrate your vital lung capacity to the class. Tell students they will be able to measure their own vital lung capacities using lungometers that they will build. If students have read *Mr. Slaptail’s Secret,* mention that they will be making a lungometer just like the one that Riff built. Ask students to predict how much air they will be able to blow out of their lungs.
2. Have the Materials Manager from each group pick up a clean plastic gallon milk container and lid, a plastic dishpan, one piece of plastic tubing and a crayon from a central area.
3. Fill each group’s tub (or have the students fill their tubs) about halfway with water.
4. Have each group calibrate the volume of its plastic jug by adding water, 500 mL at a time. One student should pour and another should label each level (500 mL, 1,000 mL, 1,500 mL, etc.) using a crayon. When the jug is filled, put on the lid.
5. Instruct two students from each group to turn the milk jug upside down and lower it into the tub, submerging the top under water.
6. While those two students continue to hold the jug in place, a third student should carefully remove the lid and slide one end of the tubing up into the submerged mouth of the jug. The lungometer is now ready for testing.
7. Before each student uses the lungometer, he or she should insert his or her own clean mouthpiece into the plastic tubing.
8. To measure vital lung capacity, each student will inhale deeply and then blow out all the air he or she can through the tubing into the jug. Then, the students holding the jug should put the lid back on and carefully turn the jug upright. This will enable them to determine the amount of water remaining. Have each student record this value on his/her “Lungometer Data Sheet.”
9. Have younger students measure their vital lung capacities once. Older students may try three times and determine the average.
10. Allow students to calculate their vital lung capacities as shown on the “Lungometer Data Sheet.” (Total volume of jug will equal approximately 4,000 mL with a standard gallon milk jug.)

Continued

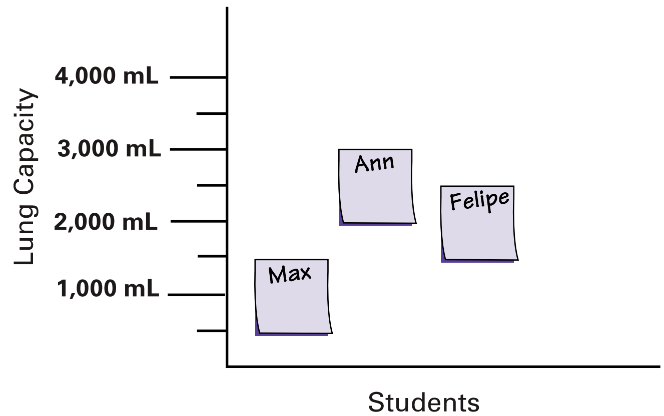
The Air unit’s *Explorations* magazine features an interview with a doctor who specializes in lung diseases (see p. 7). She is pictured with a real “lungometer,” known as a spirometer.

Did you know that the speed of the particles exhaled by a cough can reach 340 miles per hour?

QUESTIONS FOR STUDENTS TO THINK ABOUT

- Ask students, *Which types of diseases might limit a person's ability to blow out much air?* Have them use resources in your classroom or library to investigate diseases of the airways and lungs. (Examples include asthma, emphysema, some types of bronchitis, and occupational lung diseases caused by prolonged exposure to asbestos or certain kinds of dusts.)
- In the story, *Mr. Slaptail's Secret,* Mr. Slaptail improves his ability to blow air out of a lungometer like the one constructed in this activity. Ask, *What changes did Mr. Slaptail make in his lifestyle to improve his lung capacity?*

Class Graph of Vital Lung Capacities

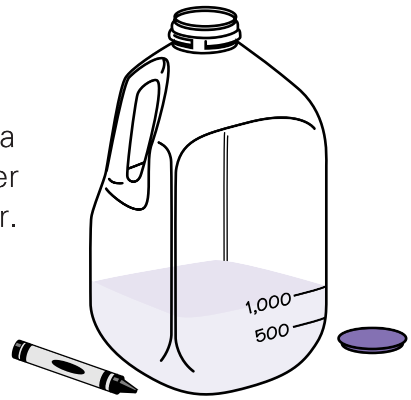


Session 2: Looking at results

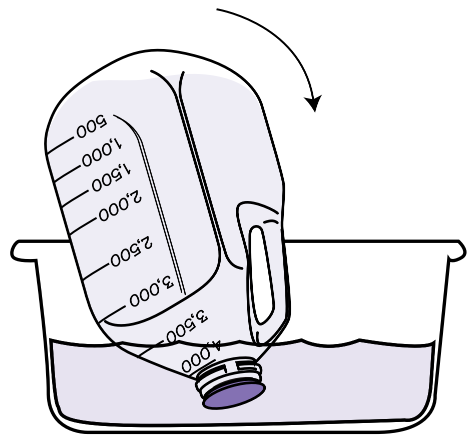
1. With younger students, draw a large graph on the board. Label the X axis "Students." Number the Y axis from 0 to 4,000 mL, using 500 mL intervals. Have the students write their names and lung capacity measurements on "sticky" notes. Help each student place his/her "sticky" at the appropriate level on the graph.
2. Older students should obtain the average value for their vital lung capacities, as shown on the "Lungometer Data Sheet." After students have completed their calculations, have them graph their average vital lung capacities as illustrated above.
3. Discuss the class results represented on the graph. Ask, *Which was the highest vital lung capacity? Which was the lowest? What range of values did we find? How could we find the average vital lung capacity for the class?*
4. Elicit a discussion of factors that might limit vital lung capacity. Ask questions such as, *What might account for differences in vital lung capacity? Do large people have larger vital lung capacities? How does exercise affect vital lung capacity? How might the vital lung capacity of a smoker compare to that of a non-smoker?*
5. Have students group their data (for example, by student height or by amounts of daily exercise) to investigate some of the questions raised during their classroom discussion.

Make a Lungometer

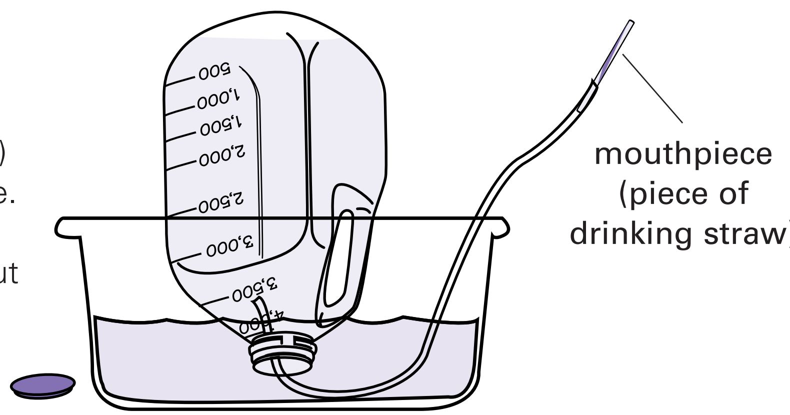
1 Fill a one-gallon plastic jug with water, 500 mL at a time. Draw a line on the jug to mark the water level each time you put in water.



2 Fill a plastic tub halfway with water. Put a cap on the jug, turn it upside down and lower it into the tub. Carefully remove the cap.



3 Put one end of a plastic tube into the jug. Insert a piece of drinking straw (a mouthpiece) into the other end of the tube. Take a deep breath and blow into the mouthpiece. Blow out as much air as you can with one breath.



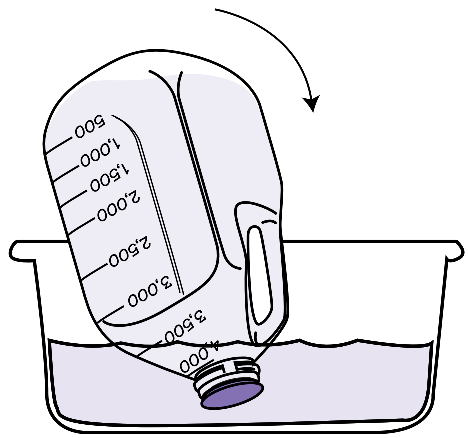
4 Put the cap back on, turn the jug over, and measure the amount of water left in the jug.

5 Write this number on your data sheet.

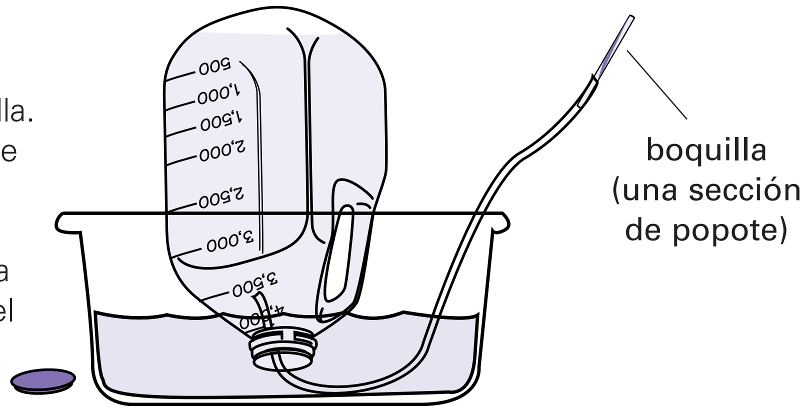
Haz un Pulmómetro

1 Llena una botella de plástico de un galón con agua usando una medida de 500 mL. Marca el nivel cada vez que añades 500 mL de agua.

2 Llena una tina hasta la mitad con agua. Tapa la botella con cuidado y viértela en la tina de agua. Quita la tapadera de la botella.



3 Pon el extremo de un tubo de plástico dentro de la botella. Coloca una sección de popote en el otro extremo del tubo. El popote servirá de boquilla. Inhala profundamente y sopla todo el aire que puedas por el tubo sin respirar otra vez.



4 Tapa la botella y girala nuevamente. Mide la cantidad de agua que quedó en la botella.

5 Escribe este número en tu hoja de datos.

Lungometer Data Sheet

6

Name ______________________________

	First Try	Second Try	Third Try	
Total volume of jug	________	________	________	mL
Amount of water left in jug	– ________	– ________	– ________	mL
Vital Lung Capacity	________	________	________	mL

1. Add all three numbers in the Vital Lung Capacity row.

____

____

+ ________

________ mL

2. Divide that number by 3 to figure out your average vital lung capacity.

______ ÷ ______ = ______

Write your answer in the space below.

3. My average Vital Lung Capacity: ________ mL

6 Hoja de Datos para el Pulmómetro

Mi nombre ______________________________

	Primer Intento	Segundo Intento	Tercer Intento	
Volumen total de la botella	______	______	______	mL
Cantidad de agua que quedó en la botella	− ______	− ______	− ______	mL
Capacidad Vital Pulmonar	______	______	______	mL

1. Suma todos los valores que obtuviste para Capacidad Vital Pulmonar. ______

______

\+ ______

______ mL

2. Divide la respuesta por tres para calcular tu capacidad promedia.

______ ÷ ______ = ______

Escribe la respuesta en el espacio abajo.

3. Mi Capacidad Vital Pulmonar promedia: [   ] mL

Heart and Lungs

7

Life Science

The heart and lungs work together to supply all the tissues in the body with oxygen and other materials, and to carry away waste products, such as carbon dioxide. All the cells in our bodies need oxygen to carry out the reactions that release energy. Carbon dioxide, a waste product of this process, is manufactured inside cells when energy is released from sugars and other molecules.

Usually, when parts of the body require more oxygen (as during exercise), the lungs and heart respond by working faster. The lungs also take in more air, so that more oxygen can be absorbed into the blood stream and transported to hard-working tissues.

We often measure heart rate by feeling the surge of blood after each heart beat at places on the body where arteries are near the surface of the skin (the wrist, for example). This recurrent surge is known as the pulse. The number of pulses per minute usually is referred to as pulse rate (heart beats per minute). The average pulse rate for a child ranges from 60 and 120 beats per minute.

Unit Links

Mr. Slaptail's Secret
Science box, p. 17

Explorations
Where Does the Air Go? p. 8

SAFETY

Do not have students measure the pulse in their necks. Too much pressure on the carotid artery can stimulate a reflex mechanism that slows down the heart. Instead, have students use their wrists (see "Radial Pulse Point," p. 26, left sidebar).

Be aware of risks to students with respiratory illnesses, such as asthma. Make sure students understand that all activities are to be carried out in an orderly fashion. Always follow district and school laboratory safety procedures.

SETUP

This investigation works best when the class is divided into two-person teams. The members of each team should take turns monitoring each other. Conduct this activity with the entire class if your students are not able to tell time.

Cut the blue and red construction paper (9 in. x 12 in.) in half horizontally to make 9 in. x 6 in. sheets.

PROCEDURE

Part 1. Making the cut-outs

1. Give each student one sheet each of blue and red construction paper. Direct students to cut out a set of lungs and a heart from each sheet, using the templates on the "Heart and Lungs

Continued

CONCEPTS

- The functions of the heart and lungs are linked.
- The heart and circulatory system work with the lungs to supply the body with oxygen and to eliminate carbon dioxide.
- The rates at which the heart and lungs work depend on levels of activity.

OVERVIEW

Students will investigate their breathing and pulse rates, and learn how these measurements are affected by physical activity.

SCIENCE, HEALTH & MATH SKILLS

- Observing
- Measuring
- Comparing data
- Drawing conclusions

TIME

Preparation: 10 minutes
Class: 30–45 minutes to make cut-outs and measurements; 30 minutes to graph and summarize results

MATERIALS

Teacher (see Setup)

- 12 sheets of red construction paper
- 12 sheets of blue construction paper
- Paper cutter

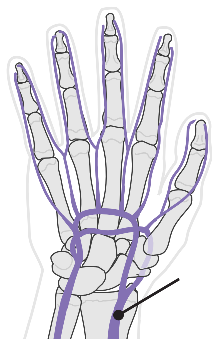
Each group will need:

- Stopwatch with a second hand, wristwatches or classroom clock

Each student will need:

- Pair of scissors
- One sheet of each color of prepared construction paper
- Copy of student sheets

RADIAL PULSE POINT



The safest and most common site to check pulse is on the thumb-side of the wrist (radial pulse).* Use the middle finger and ring finger together to apply slight pressure at the location shown above.

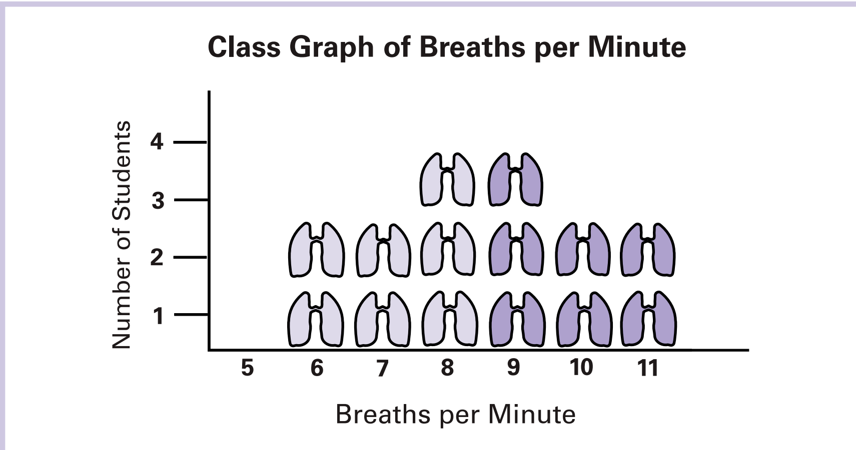
* Pulse site recommended for the general public by the National Heart, Lung, and Blood Institute, National Institutes of Health.

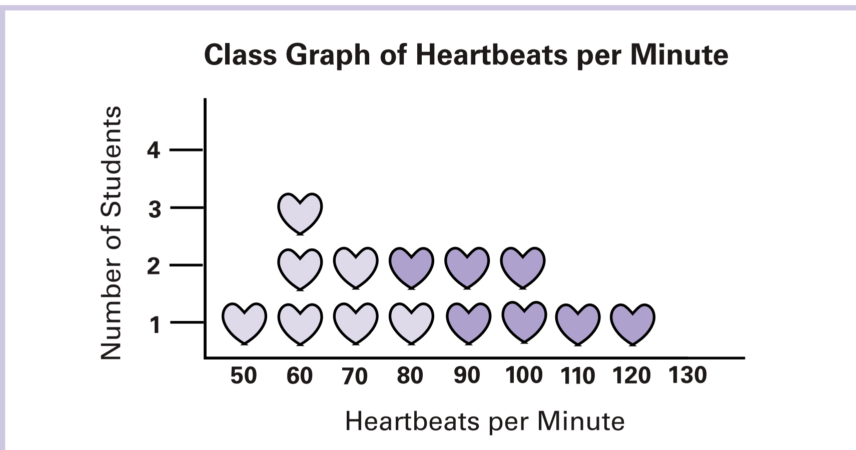
Cut-Outs" student sheet. (This can be integrated into a mathematics or art lesson as a symmetry activity.) Students should write their names on their cut-outs.

Part 2. Gathering data

1. Explain to students that they will be investigating their breathing and heart rates. Make sure they understand that a "rate" is a measure of "how fast" or "how slow" something is happening.
2. Group the students into pairs. Ask them to sit quietly and breathe normally. Have one student count the number of times his/her partner inhales (breathes in) in one minute, and record the results on the "Heart and Lungs Data Sheet." Older students can time themselves, using a wristwatch or stopwatch. If a student has difficulty observing the breathing of his/her partner, instruct the student being observed to dangle a strip of tissue in front of his/her nose. Have students repeat the measurements at least three times to calculate an average. Then instruct the students to switch jobs.

   With younger students, conduct this procedure as a whole class activity. You can either time them or direct the timing, while students take turns counting and recording their partners' breathing rates.
3. Prepare the students to measure their pulse rates (heart beats per minute) by demonstrating the safest way to locate a pulse point (see "Radial Pulse Point," left sidebar). Give students time to locate their pulse points and practice counting beats.
4. Have students measure their heartbeats by counting the number of times they feel a tiny surge at their pulse points, while their partners time them for 15 seconds. Older students should enter this value on their worksheets and multiply by four to obtain the number of beats per minute. They should take three readings. Younger students may add this value four times to find beats per minute. Have the students switch jobs and repeat the process. Again, with younger students, you probably will want to direct the activity and measure the time.
5. Next, tell the students that they are going to investigate their breathing and pulse (or heart) rates after physical activity. Ask, *What do you think will happen to your heart rate when you exercise? What about your breathing rate?* Have one member of each team run in place for one minute and sit down. Have their partners determine their breathing rates again. Older students should repeat this procedure three times. Then, let the students switch jobs and repeat the process. This step should be teacher-directed for younger students.
6. To investigate pulse rate after activity, have the students repeat the process described in steps 3 and 4 after running in place for one minute.





QUESTIONS FOR STUDENTS TO THINK ABOUT

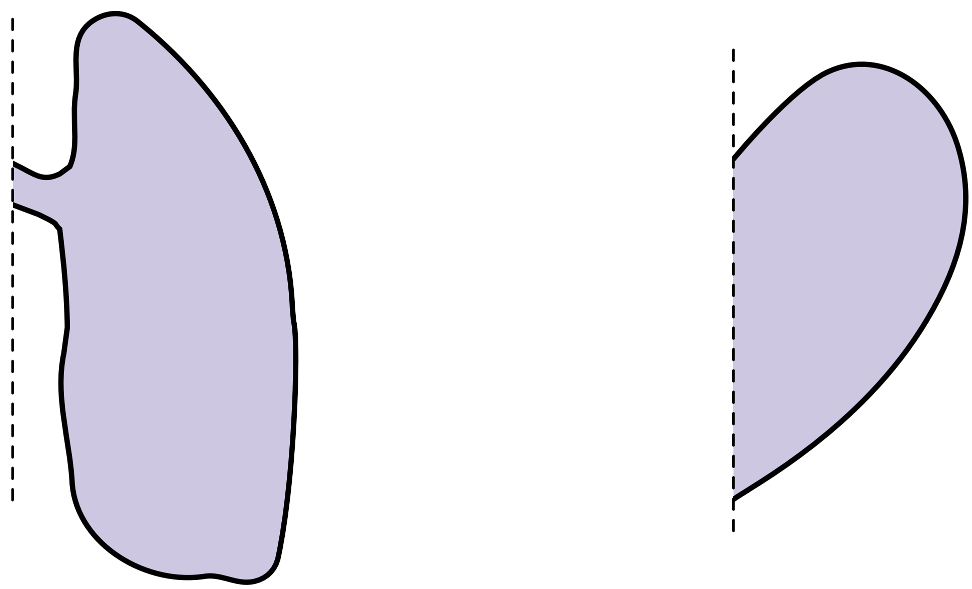
- Do you think that trained athletes have higher or lower breathing and pulse rates than students at rest? During activity? How could this be investigated?
- How do your "rates" compare to those of your parents?
- How might activities like smoking affect heart and breathing rates during exercise?
- What do you think might have happened to Mr. Slaptail's breathing and pulse rates after he stopped smoking?

Part 3. Graphing

1. Draw two large grids for class graphs on chart paper or on the board. Label one grid "Heartbeats Per Minute" and the other "Breaths Per Minute." Lines on the vertical axis should be 6 cm apart. Lines on the horizontal axis should be approximately 12 cm apart. Make sure students understand that they were able to quantify their heart rates by counting the tiny surges of blood moving through an artery.
2. Using blue for resting rate and red for active rate, have students write their names and rates on the appropriate cut-outs. Tape students' cut-outs on the appropriate class graphs OR help each student position his or her cut-outs on the graphs.
3. Ask, *Where are most of the blue hearts on the graph? How about the red hearts? Where are the blue lungs? The red lungs? How does exercise affect a person's breathing rate? Heart rate?* Help students notice that heart and breathing rates change together.

Heart and Lungs Cut-Outs

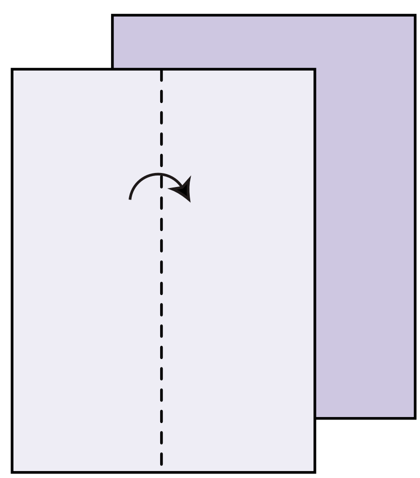
1. Cut out the two shapes below.

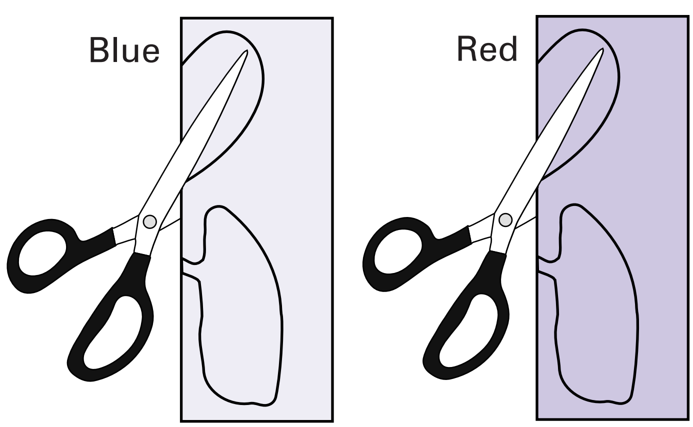


2. Fold your red and blue sheets of paper in half the long way.

3. Trace around the shapes on your blue paper. Cut along the lines and open your heart and lung figures.

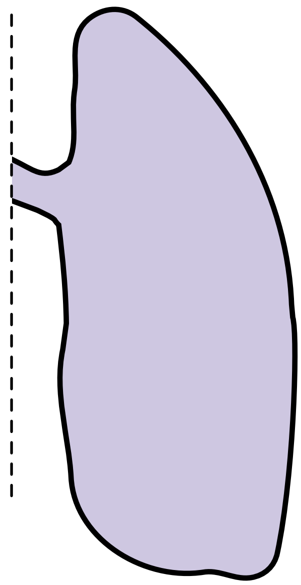
4. Lay the shapes on your red sheet. Trace and cut out the figures in the same way.

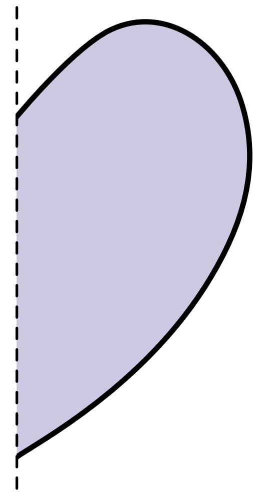




Figuras de Corazón Pulmones

1. Recorta las dos figuras que están abajo.

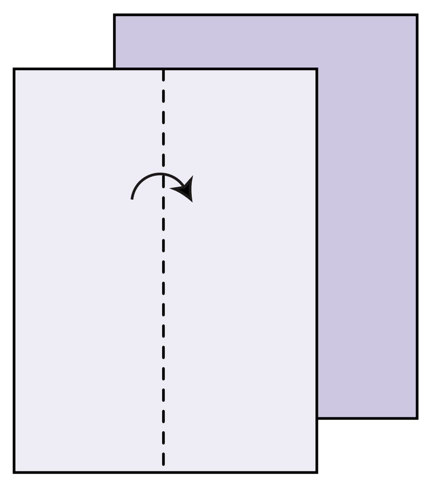


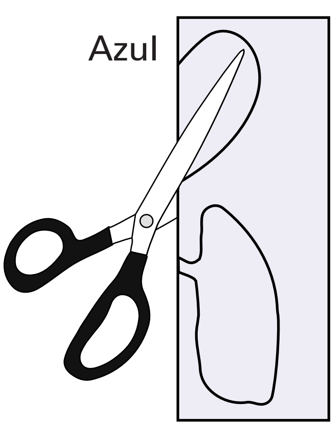


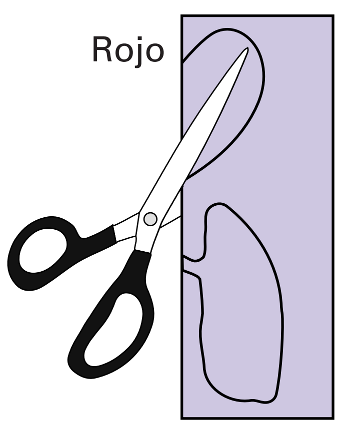
2. Dobla tus papeles (uno rojo y uno azul) a lo largo.

3. Pon las figuras encima del papel azul y traza alrededor de cada una. Recórtalas y abre tus figuras de corazón y pulmones.

4. Ahora, pon las figuras encima del papel rojo y recórtalas también.







Heart and Lungs Data Sheet

Name ______________________________

Breathing

1. Have a partner count how many times you breathe out during one minute. Try this three times and write the numbers in the boxes to the right. Add these three numbers and write your answer in the box at the bottom.

[ ]
[ ]
[ ]
\+ ________
[ ]

2. Divide this number by 3 to find your average breathing rate (number of breaths per minute).

__________ ÷ 3 = ______________
Average Breathing Rate

Pulse

1. Now, have a partner count your pulse beats for 15 seconds. Multiply this number by 4. Try this three times and write the numbers in the boxes to the right. Add all three numbers and write your answer in the box at the bottom.

[ ] × 4 = [ ]
[ ] × 4 = [ ]
[ ] × 4 = [ ]
\+ ________
[ ]

2. Divide this number by 3 to find your average pulse rate (number of heartbeats per minute).

__________ ÷ 3 = ______________
Average Pulse Rate

Circle One:

These are my RESTING • ACTIVE rates.

Hoja de Datos-Corazon y Pulmones

Mi Nombre ______________________________

Respiración

1. Pide a tu compañero que cuente las veces que respires en un minuto. Hazlo tres veces y escribe los valores aquí.

[ ]
[ ]
[ ]
\+ ______
[ ]

2. Divide este numero por tres para obtener un promedio de tu tasa de respiración (veces por minuto).

__________ ÷ 3 = ______________________
Tasa de Respiración Promedia

Pulso

1. Ahora, pide a tu compañero que mida 15 segundos mientras te tomas el pulso. Hazlo tres veces y escribe los valores aquí

[ ] × 4 = [ ]
[ ] × 4 = [ ]
[ ] × 4 = [ ]
\+ ______
[ ]

2. Divide este numero por 3 para obtener un promedio de tu tasa cardiaca (latidos por minuto)

__________ ÷ 3 = ______________________
Tasa Cardiaca Promedia

Marca Uno:

Estos son mis resultados cuando estoy DESCANSANDO • ACTIVO.

Indoor Air Pollution

Secondhand smoke is also called environmental tobacco smoke (ETS). Exposure to ETS is sometimes called involuntary or passive smoking.

ETS contains more than 4,000 substances, several of which are known to cause cancer in humans or animals.

Children are particularly vulnerable to the effects of ETS because they are still developing physically, have higher breathing rates than adults, and have little control over their indoor environments.

Exposure to ETS can cause asthma in children who have not previously exhibited symptoms, and trigger asthma attacks or make symptoms more severe in those already diagnosed with asthma.

Asthma is the most common chronic childhood disease, affecting, on average, 1 in 13 school-aged children.

http://www.epa.gov/smokefree/

The "environments" in which we spend the most time are our homes, schools and offices. And although we tend to associate air pollution with outdoor environments, in many cases, levels of contaminants are higher indoors. Energy-efficient designs can cause certain substances in the air to become concentrated inside buildings. The Environmental Protection Agency (EPA) estimates that 30% of all buildings and homes in the U.S. contain enough pollutants to affect people's health. For example, indoor air pollutants can be responsible for allergic reactions, infectious diseases, chronic irritation of parts of the airways, and toxic reactions (including damage to tissues and organs, such as the liver, central nervous system and the immune system).

Air pollutants are carried into our airways and lungs when we breathe. Our respiratory systems have a variety of defense mechanisms against pollutants. For example, particles can be filtered out in the passages of the nose. When particles are inhaled into the lungs, some are trapped in mucus and transported into the esophagus; others are surrounded and destroyed by special cells. Sneezing and coughing help prevent irritating gases and dusts from entering the rest of the respiratory system. Some gases that are inhaled into the lungs and absorbed into the bloodstream can be detoxified by the body.

Despite all of these defense mechanisms, some pollutants enter and remain in the body. Those that stay within the lungs can cause ongoing or periodic irritation. Materials absorbed into the bloodstream can be carried to other parts of the body, where they can damage organs, such as the kidneys or liver.

Prevention is the best way to avoid the build-up of harmful airborne substances in our indoor environments. Careful use of pesticides, cleaning compounds and other chemicals in the home reduces our exposure to potentially toxic gases and vapors. Maintaining cooling and heating systems properly, making sure that sufficient fresh air flows into buildings, and eliminating damp places where mold and bacteria grow all contribute to a healthier indoor environment.

COMMON INDOOR AIR POLLUTANTS

- Particles and chemical by-products of combustion (heating, cooking or smoking)
- Mites and parts of dead insects, like cockroaches
- Mold spores
- Animal dander
- Formaldehyde (chemical used in building materials, fabrics and foam insulation)
- Household chemicals (cleaners, pesticides, paints, etc.)
- Personal care products (hairspray, acetone in products like nail polish remover, etc.)
- Lead dust (from old paints)

Dust Catchers

8

Environment and Health

Dust and other particles found indoors can come from a variety of sources and may include cigarette smoke, animal dander (flakes of dead skin), insect parts, mold spores, fibers, and/or dust mites and their droppings.

Indoor dust can pose a significant health problem to individuals who are allergic to any one of the particles it contains. Animal dander, mold spores and dust mites are especially common indoor allergens (allergy-causing agents). They can cause simple allergies of the upper respiratory system ("hay fever" symptoms). Dust mites also have been linked to allergic diseases of the airways, such as asthma.

Several measures can help to control dust in indoor environments. Filters remove larger particles from the air. Keeping living areas dry and well ventilated also helps to limit the growth of molds (and dust mites that can feed on molds), which prefer damp places. Eliminating curtains and other materials that hold dust may be necessary, in some cases, to control allergies in susceptible individuals.

Unit Links

Mr. Slaptail's Secret
Science boxes, pp. 3 and 7

Explorations
Cover; Not Such a New Issue, p. 5

SAFETY

Be aware of risks to students with respiratory illnesses, such as asthma. Make sure students understand that all activities are to be carried out in an orderly fashion. Always follow district and school laboratory safety procedures.

SETUP

Assemble a "dust catcher," as described on the "Make a Dust Catcher" student page, for the students to use as a model when they construct their own. To facilitate sharing of materials, organize students into groups of four. Each student should make his or her own dust catcher.

Cut the construction paper (9 in. x 12 in.) in half horizontally to make 4-1/2 in. x 12 in. sheets.

PROCEDURE

Session 1: Dust Catchers

1. Create a small cloud by shaking a cotton ball dipped in baking soda (or cornstarch or baby powder, or use a dusty eraser; see Safety, above). Shine a flashlight through the dust cloud. Ask, *What are we seeing? Do you think this always is in air? How could we find out?*

Continued

CONCEPTS

- Dust consists of individual particles of different substances.
- Even air that appears to be clean may contain dust and other pollutants.

OVERVIEW

Students will make a simple device to collect particles from the air at home or in the classroom.

SCIENCE, HEALTH & MATH SKILLS

- Observing
- Measuring
- Estimating
- Graphing
- Drawing conclusions

TIME

Preparation: 30 minutes
Class: 30 minutes to make collectors; 30–45 minutes to observe particles; 30–45 minutes to make graphs

MATERIALS

Teacher (see Setup):

- Baking soda (or cornstarch, baby powder, or dusty eraser)
- Cotton balls
- Flashlight with batteries

Each group will need:

- Glue sticks
- Knife, plastic (or spreader)
- Petroleum jelly
- Wax paper

Each student will need:

- Hand lens (magnifier)
- Pair of scissors
- Rubber band, large
- Prepared sheet of construction paper
- Sheet of marked graph paper, 10 cm x 10 cm
- Copy of student sheet

Dust mites are too tiny to be seen even with a magnifying glass or low power microscope. More than 5,000 of them can fit on a fingernail!

Chips of old paint containing lead or lead-contaminated dust are major sources of lead exposure for U.S. children. Although leaded paint was banned in the 1970s, existing paint in older housing poses a serious health threat.

Paints can be tested for the presence of lead using a home test kit or by sending samples to a lab. Contact your city, county or state health department if you have questions about lead and paints.

2. Show students the dust catcher that you have made and explain that they each will make a similar one to take home. They will place the dust catchers in areas of their homes they predict will have the most air pollution. After one or two weeks, they will bring the dust catchers back to school and examine them for particles.
3. Guide students as they construct their dust catchers, following steps described on the "Make a Dust Catcher" student sheet.
4. Have students take their dust catchers home and place them on a flat surface to catch dust for one or two weeks.

Session 2: Observing

1. When all students have brought their dust catchers back to school, open a general discussion about the appearance of the dust catchers. (Some will have a visible sprinkling or layer of particles; others will have few or no visible particles.)
2. Have the Materials Managers collect enough hand lenses for their groups. Each student should examine the overall appearance of the dust on his or her collector and, if time permits, on the collectors of other members of the group.
3. Have each student use a magnifier to count the number of particles in 10 squares chosen randomly on the grid. (You may need to vary the number of squares counted, depending on the type of graph paper used. Paper with a grid size of approximately 1 cm works well.)
4. Have each student record the number of particles he or she counted in the appropriate place on the "Make a Dust Catcher" sheet (if you have made a copy for each student), or have students write the number in their journals or notebooks.
5. If you have one or more microscopes available, help students to examine their grids under higher magnification. You may want to trim the construction paper around the graph paper square to help it fit under the microscope.
6. Ask, *What kinds of particles did you capture?* Students are likely to find small hairs, tiny pieces of ash, crumbs and bits of thread or lint. With the aid of microscopes, students also may see pollen grains, pieces of molds and very small insect parts. Have them draw some of the particles they have observed.
7. For further discussion, refer students to the various sources of household dust pictured on the front cover of this unit's *Explorations* magazine.

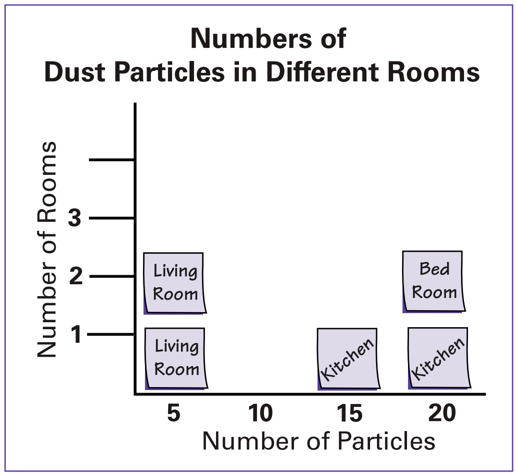
Session 3: Graphing results

1. Conduct a brief survey of the values that students obtained for their dust counts. Create a chart on the board similar to the one on the right, taking into consideration the range of counts reported by the students.

Continued

Photo of man removing paint: CDC\11328\Dawn Arlotta, Cade Martin. Photo of mite: CDC\5447.

2. Help each student place a dot or "sticky note," labeled with the type of room tested, on the appropriate place on the graph.



3. Discuss the survey results with the class. Ask students to identify areas in their homes that have more or less dust. Also ask, *Did different kinds of dust collect on dust catchers in different rooms?* Talk about ways in which dust can be reduced or eliminated.

VARIATIONS

- Older students may enjoy making two or more dust catchers each, so that they can compare the number and kinds of particles captured in different rooms of their homes, or between indoors and outdoors.
- Young students may prefer making the dust catchers as a class project and positioning catchers in different places in the classroom.
- If anyone in the class has allergies to dust or any other substances, invite them to share their experiences with the rest of the class.

QUESTIONS FOR STUDENTS TO THINK ABOUT

- One character in the story, *Mr. Slaptail's Secret,* suffers from several common allergies. Ask students, *Who is she? What does she do to control her allergies? Does anyone else in the story have allergy problems?*
- Open a discussion on indoor air pollution elsewhere in the world. Indoor air pollution in the form of particles is a much greater problem in developing countries, where wood and coal still are used for cooking. Ask students, *Why do you think things are different in some other countries?*
- Have students conduct a survey of asthma and allergy sufferers at school or at home. Ask, *What types of allergens* (substances that cause an allergic response) *trigger each person's asthma or allergy symptoms? Are their symptoms more or less severe during certain times of the year?*

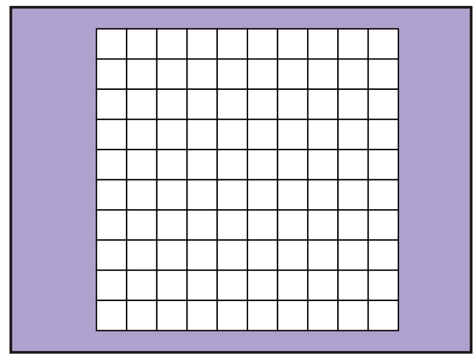
8

Make a Dust Catcher

Name ______________________________

You will need a glue stick, one-half sheet of construction paper, a 10-cm x 10-cm sheet of graph paper, petroleum jelly, a sheet of wax paper, a plastic knife or spreader, one large rubber band and a hand lens.

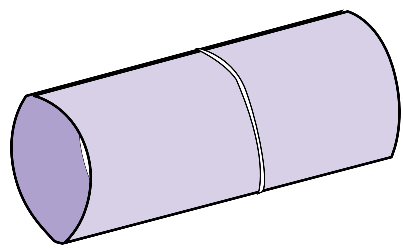
1. Glue the graph paper onto the center of the construction paper. Cover the grid with a piece of wax paper. Glue the outside edges of the wax paper to the construction paper. Spread a very thin layer of petroleum jelly over the wax paper.



2. Roll the construction paper into a large tube, with the graph paper on the inside. Be careful not to overlap the petroleum jelly onto the construction paper. Fasten the tube with a rubber band.

3. Carefully take your tube home.

4. Remove the rubber band and spread out the dust catcher. Place it somewhere in your house where you think there might be dust.



5. After one or two weeks, roll up your dust catcher. Take it to school.

6. Using a hands lens, look at the specks on the graph paper. Can you recognize any of them? Draw one of them in the space below.

7. Count the particles inside 10 squares. Write this number here. ______________________

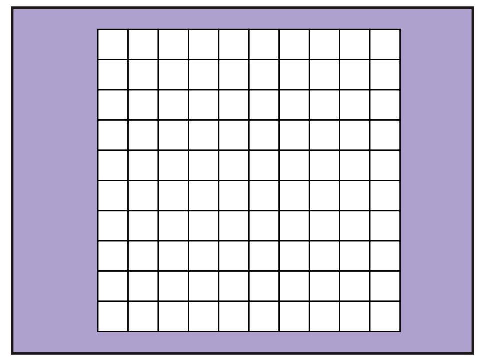
Haz un Atrapa-Polvo

8

Mi nombre ______________________________

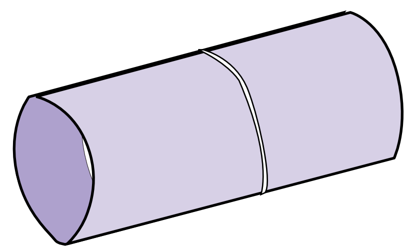
Vas a necesitar media hoja de papel de construcción, una liga grande y un pedazo de papel cuadriculado de 10 cm x 10 cm.

1. Usa pegamento para colocar el pedazo de papel cuadriculado en medio de la otra hoja de papel. Cubre el papel cuadriculado con un pedazo de papel encerado y usa pegamento o cinta transparente para fijarlo. Aplica una capa muy delgada de petrolato al papel encerado.



2. Enrolla el papel para formar un tubo grande, dejando el lado con el papel cuadriculado adentro. Ten cuidado de no sobreponer la cinta o el petrolato encima del papel de construcción. Ata el tubo con una cuerda o liga.

3. Lleva el tubo a tu casa con cuidado.



4. Quita la cuerda y desenrolla el Atrapa-Polvo. Ponlo en algún sitio en tu casa donde crees que haya polvo.

5. Después de una o dos semanas, enrolla el Atrapa-Polvo y llévalo a la escuela.

6. Usa una lupa para examinar las partículas que fueron atrapadas en tu Atrapa-Polvo. ¿Puedes identificar algunas de ellas? Dibuja una de ellas en el espacio abajo.

7. Cuenta el número de partículas dentro de diez de los cuadritos del papel. Escribe este número aquí. ______________________________

9

Fungus Among Us

Environment and Health

CONCEPTS

- Fungi grow from spores.
- Fungi spores are present almost everywhere.
- Molds and other fungi grow in damp places.

OVERVIEW

Students will grow and observe bread mold and other kinds of common fungi.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Observing
- Recording qualitative data
- Drawing conclusions

TIME

Preparation: 10 minutes
Class: One session of 20 minutes to set up cultures; daily 10-minute observations for 3–7 days; concluding session of 30–45 minutes to make final observations

MATERIALS

Teacher (see Setup)

- Transparency of "Common Bread Mold" student sheet
- Bread mold, *Rhizopus stolonifer* (optional, order from a science educational supply company)

Each group will need:

- Piece of old bread (see Setup)
- Pipet or dropper

Each student will need:

- Clear resealable plastic bag, 4 in. x 6 in. (or small jar or plastic container)
- Hand lens (magnifier) or 6 microscopes
- Disposable plastic gloves (optional)
- Copy of the student sheets (pp. 43, 44)

The old saying, "There's a fungus among us," contains an element of truth. There are at least 100,000 different fungus species, and members of the fungus kingdom (collectively known as fungi) are found almost everywhere. Fungi, along with some bacteria and other organisms, are the decomposers of our world. They break down the remains of dead plants, animals and other living things and, in the process, obtain the energy they need to grow and reproduce.

Unit Links

Mr. Slaptail's Secret
Science box, p. 20

Explorations
Let's Talk About Indoor Air, pp. 2–3

Fungi are essential for the continued recycling of nutrients into the soil and the release of carbon dioxide into the air. However, fungi also can be a nuisance to humans. For example, fungi do not discriminate between fruits in a natural setting (such as those that have fallen on the ground) and fruits in the refrigerator. Many fungi attack living organisms and are sources of disease in both plants and animals. Fungi grow especially well in damp places and can attack cloth, paint, paper, leather, cable insulation and even photographic film. The various fuzzy-looking fungi that grow on damp surfaces often are called molds.

Fungi spread by producing spores—tiny particles that can remain suspended in the air for long periods of time. The powdery appearance and bright colors of many kinds of molds actually are caused by the spores they have produced. Some fungi, such as yeasts, are one-celled organisms. Most, however, consist of mats of slender tubes or hyphae (singular, hypha). In some fungi, the hyphae are loosely packed and easy to see. In others, the hyphae are packed so densely that the structure appears solid. Mushrooms, the spore-producing parts of some fungi, are good examples of structures composed of these tightly packed filaments.

Inside buildings, fungi can grow in damp places, such as basements, shower curtains, food storage areas and window air-conditioning units. The spores produced by molds can contribute significantly to indoor air pollution and can trigger allergic reactions in some individuals. Fortunately, indoor air pollution from mold spores can be controlled by keeping humidity levels low (below 30%), by improving ventilation, and by keeping damp areas clean.

Bread mold (*Rhizopus stolonifer*) is a common fungus that is easy to grow and observe. In this activity, students also may see greenish colonies of *Penicillium* (the fungus that produces the antibiotic, Penicillin) and other related fungi.

Continued

Rhizopus stolonifer (Black bread mold) is most commonly found growing on bread surfaces and on soft fruits, such as tomatoes (above). Because its spores are common in the air, this mold can be grown within a few days by keeping moistened pieces of bread in an enclosed, humid environment.

Rhizopus stolonifer in plum tomato © Frank R. Segarra.

SAFETY

While common molds that grow on bread generally are harmless, some students may be allergic to the spores they produce. Therefore, have your students observe the molds without opening the sealable bags or other containers in which they have been grown. Wear disposable plastic gloves if you plan to handle mold samples for demonstration purposes. Pour diluted chlorine bleach (10%) into the bags containing mold samples before disposal.

SETUP

A day or two before you plan to begin this activity, ask each student or group of students to bring a piece of bread to class (bakery-type or "natural" bread without preservatives works best). As an alternative, you many want to consider baking bread or having students bake bread at home with a parent as part of this activity (see p. 41–42 for recipes).

If you do not wish to grow bread mold in the classroom, pure cultures can be purchased. (See "Obtaining Fungi," right sidebar.)

OBTAINING FUNGI

It is easy to obtain pure cultures of many kinds of common, non-pathogenic (non disease-causing) fungi. In addition to bread mold (*Rhizopus stolonifer*), other interesting members of this kingdom, including penicillin mold (*Penicillium notatum*), yeasts (*Saccharomyces sp.*) and common black mildew (*Aspergillus niger*), can be purchased on petri dishes (covered, clear plastic dishes) or in test tubes from commercial science educational supply companies.

PROCEDURE

Part 1. Getting started

1. Hold up a piece of bread and ask the students if they know who or what might use it for food. Prompt them to consider all the possibilities. Follow by asking if they ever have seen a rotten apple, moldy slice of bread, etc. Point out that when something is rotting, other living things are using that object for food. Ask, *How do you think these living things spread from place to place?* Remind the students of the particles they observed in the "Make a Dust Catcher" activity. Mention that some of the tiniest particles in dust are produced by organisms as a means of spreading to other places. Tell students they will be able to observe some living things that spread in this way.
2. Have Materials Managers pick up materials for all members of their groups. Have each student label a container with a piece of tape on which the student has written his/her name.
3. Direct the students to examine their bread samples with a magnifying glass, and draw or describe what they predict will happen to the bread in the first space on the "Bread Mold Observations" sheet. In the second space, have students draw or describe the bread as it appears at the beginning of the investigation.
4. Each student should place the bread in his/her container and add a few drops of water. Store the containers in a dark corner or cupboard.

Part 2. Observations

1. For the next 3–7 days, have students observe their cultures

Continued

(with and without a hand lens) at one- or two-day intervals. Do not allow students to open the containers in which molds are growing. Some breads may grow mold in as little as 24 hours; others may require seven days or more.

2. Have students record their observations on their data sheets.

Part 3. Final observations

1. When all or most cultures (some breads treated with preservatives may not grow mold within the time allotted) have visible molds, instruct students to make their final observations.
2. As a class, decide how many different kinds of molds are present on the bread samples. Have students make a list of the characteristics they use to distinguish one mold from another. Prompt them to think about whether some molds seem to grow on certain types of bread. Ask, *How did the mold get to the bread?* (Spores were present in the air and landed on the bread.)
3. One fungus that will be present is bread mold. It consists of dark gray threads forming a loose, tangled mat that may reach a centimeter in thickness. Find several samples of bread mold from the class's cultures, and give a container with bread mold to each group (see Safety, p. 39).
4. Have students observe the bread mold inside their containers with their magnifying glasses. They will be able to see the individual threads with small dark dots at the ends. The dots are the spore-producing parts of the fungus. (The actual spores are very tiny.) If you have access to microscopes, place a few strands of the bread mold (using forceps or tweezers) under microscopes for students to observe. Students will be able to see the tubular structure of the filaments (hyphae), the round, dark heads that produce spores and, depending on the magnification, some of the tiny, round spores. Project a transparency of the "Common Bread Mold" page to help students spot the different parts.
5. Conclude by leading a class discussion of the role of molds in causing indoor air pollution. You may wish to refer to the story, *Mr. Slaptail's Secret,* in which Rosie, one of the characters, is allergic to mold spores.

VARIATIONS

- Have students invent names for the different kinds of molds they grew and create a key to identify each one.
- Make one or more kinds of bread with your students. Try using a recipe with baking soda for leavening, and compare the results with a recipe that uses yeast (a fungus). Mention that, in both cases, the bubbles in the dough are caused by carbon dioxide gas being released into the dough.

A SOURCE FOR MEDICINE

Cyclosporin, a "wonder drug" developed in 1979, comes from a fungus that lives in soil. This medicine is given to organ-transplant patients so that their immune systems will not attack and destroy the new tissue.

USES OF FUNGI

- Yeasts (tiny one-celled fungi) are used for baking and the production of beer.
- Many fungi are sources of antibiotics and other medicines.
- Some kinds of fungi inhabit the roots of trees, crops and other plants, and help the plants take up nutrients from the soil.

QUESTIONS FOR STUDENTS TO THINK ABOUT

- Where can we find molds and other fungi in the natural world?
- What would happen if there were no fungi?
- What can we do in our homes to limit mold growth?

Bread Recipes

BREADS

Soda Bread

6 cups all-purpose flour
2 teaspoons baking powder
2 teaspoons baking soda
2 teaspoons salt
3 cups buttermilk (or add 2–3 tablespoons vinegar to 3 cups of milk, stir and use as buttermilk)

Optional: Mix 1 cup raisins or chopped nuts into dry ingredients.

Preheat oven to 375°F. Stir flour, baking powder, baking soda and salt together in a large bowl. Add buttermilk and stir to moisten the dry ingredients. Form the dough into a ball and knead several times. Shape the dough into two round loaves about $1\frac{1}{2}$ inches thick on a greased cookie sheet. Cut an "x" on the top of each loaf. Bake for 40 minutes.

BREADS

No Knead Bread

$1\frac{1}{2}$ cups milk	$1\frac{1}{2}$ cups water
$\frac{1}{2}$ cup vegetable shortening	3 packages dry yeast
$\frac{1}{4}$ cup sugar	3 eggs
2 tablespoons salt	$9\frac{1}{2}$ cups flour

Preheat oven to 350°F. Scald milk by bringing it just to the boiling point in a large, heavy pan. Add shortening, sugar and salt to hot milk. Let milk begin to cool and add water. When mixture becomes lukewarm, add yeast and mix well. Blend in the eggs and add half of the flour. Mix thoroughly. Slowly add the remaining flour. When the dough becomes too stiff to stir with a spoon, place it on a floured surface and knead briefly to blend ingredients. Shape into three loaves and place in greased loaf pans. Cover with a clean cloth and let rise for one hour, away from drafts. Bake for 45 minutes.

Recetas para Pan

PAN

Pan de Soda

6 tazas de harina
2 cucharaditas de polvo de hornear
2 cucharaditas de bicarbonato de sodio
2 cucharaditas de sal
3 tazas de suero de leche (o añadir 2–3 cucharas de vinagre a 3 tazas de leche entera y mezclar)

Opcional: Se puede mezclar 1 taza de pasitas o nueces picadas con los ingredientes secos.

Precaliente el horno a 375°F. Mezcle la harina, el polvo de hornear, el bicarbonato y la sal en un recipiente hondo. Vierta la leche sobre estos ingredientes. Amase todo rápidamente y forme una bola. Divida la masa en dos y forme dos círculos en una bandeja de horno engrasada. Aplaste el pan un poco con las manos. Con un cuchillo corte una cruz sobre la superficie de cada pan. Hornee por 40 minutos.

PAN

Pan Fácil

$1\frac{1}{2}$ tazas de leche
$\frac{1}{2}$ taza de manteca vegetal
$\frac{1}{4}$ taza de azúcar
2 cucharas de sal
$1\frac{1}{2}$ tazas de agua
3 paquetes de levadura para pan
3 huevos
$9\frac{1}{2}$ tazas de harina

Precaliente el horno a 350°F. Caliente la leche en una cazuela. Cuando la leche esté casi al punto de ebullición, añada la manteca, el azúcar y la sal. Deje que la mezcla empiece a enfriar y vierta el agua. Cuando la mezcla esté tibia, añada la levadura y revuélvala bien. Añada los huevos y la mitad de la harina y mezcle nuevamente. Poco a poco añada el resto de la harina. Cuando ya no se pueda revolver con una cuchara, ponga la masa sobre una superficie harinada y amase suavemente para terminar de mezclar los ingredientes. Forme la masa en tres panes y coloque cada uno en un molde engrasado. Déjelos reposar tapados con un paño durante una hora. Hornee por 45 minutos.

Bread Mold Observations

Observaciones de Moho

Name/Mi nombre ___

My Prediction/ Mi Predicción

Day/Día ___

Day/Día ___

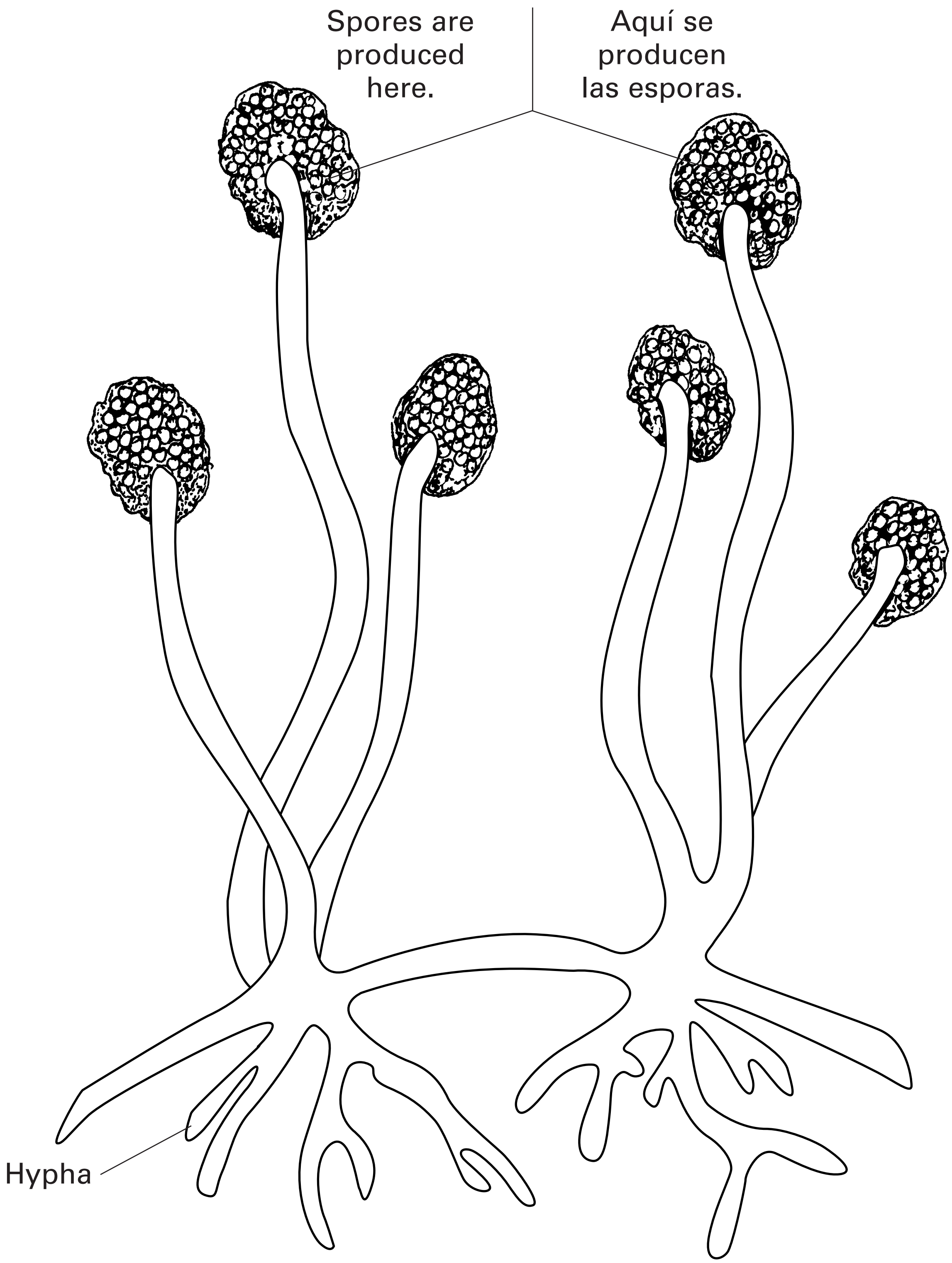
Day/Día ___

Day/Día ___

Day/Día ___

Common Bread Mold

Moho de Pan



There's Something in the Air

10

Environment and Health

Indoor air pollution can occur in many ways. Some indoor pollutants are produced when something burns. These include gases, such as carbon monoxide, as well as particles, like those in soot. Tobacco smoke introduces these pollutants and many other chemicals into the air. Other indoor pollutants, such as pollen, spores, insect parts and droppings, and dust mites come from biological sources. Formaldehyde, a poisonous chemical, can be given off by particle board, carpeting, insulating foam, some cleaners, permanent-press fabrics and tobacco smoke. These and many other sources (such as solvents and cleaners, paints, glues and dry-cleaning fluids) add potentially harmful chemicals to the air.

The concentration of such compounds is much higher indoors than outdoors, in part because many modern, energy-efficient buildings are designed to prevent air leaks or the introduction of outside air into heating or cooling systems. With inadequate ventilation, chemicals and other substances become concentrated in these closed environments.

To reduce indoor air contamination, heating and cooling systems should by serviced regularly. Humidifiers and air conditioners should be cleaned frequently to reduce places where molds and bacteria can multiply. New buildings should be ventilated thoroughly before being occupied. Other measures that can reduce the build-up of harmful indoor pollutants are given on page 3 of this unit's *Explorations* magazine.

Unit Links

Mr. Slaptail's Secret
Science box, p. 24

Explorations
Tips for Healthy Living, p. 3; We Can Make a Difference! p. 6

SETUP

Before conducting the activity, measure and cut string or yarn into eight 6-meter pieces (one piece per group). With a marker or pieces of tape, make lines at 2-meter, 4-meter and 6-meter points (adjust distances depending on the size of your classroom) on each piece of yarn. Older students can mark their own string segments.

This is a whole-class activity that can be carried out as a discovery lesson without prior introduction.

PROCEDURE

Part 1: Indoors

1. Arrange the pieces of string on the floor like spokes of a wheel around a central point in the room (see illustration, p. 46). Divide the class into three groups. Tell the members of one group to sit on the 2-meter marks on the various pieces of

Continued

CONCEPTS

- Many kinds of gases and particles travel through, and become dispersed in air.
- Substances in air become concentrated in enclosed spaces.

OVERVIEW

To model the movement of pollutants through indoor and outdoor air, students will compare the dispersal of odors indoors and outdoors.

SCIENCE, HEALTH & MATH SKILLS

- Observing
- Measuring
- Comparing data
- Drawing conclusions

TIME

Preparation: 20 minutes
Class: 15 minutes indoors; 15 minutes outdoors; 20 minutes to compare results

MATERIALS

Teacher (see Setup):

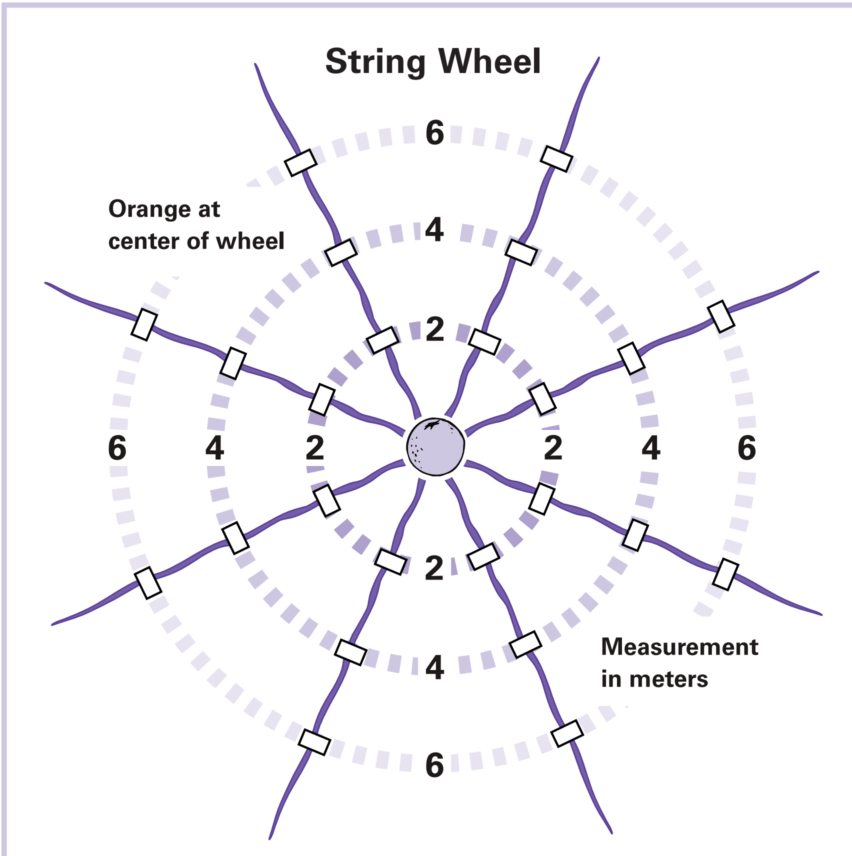
- 48 meters of string or heavy yarn (6-meter length piece per group of 3 students)
- 3/4-in. roll of masking tape
- Marker
- Orange
- Stopwatch with a second hand, wristwatch or classroom clock

Optional:

- 8 metric tape measures or meter sticks
- Sharp knife

Asbestos fibers (1500X).

Asbestos is an indoor pollutant often discussed in relation to schools. A naturally-occurring mineral, asbestos is fireproof, a good insulator and virtually indestructible. It was used in many buildings until 1980. Unfortunately, asbestos fibers have been linked to lung disease when they are inhaled over long periods of time. However, people living or working in buildings with asbestos need to be concerned only if the asbestos is shedding or if asbestos panels are cracked or shredded.



yarn. Tell the second group to sit on the 4-meter marks, and the third group to sit on the 6-meter marks.

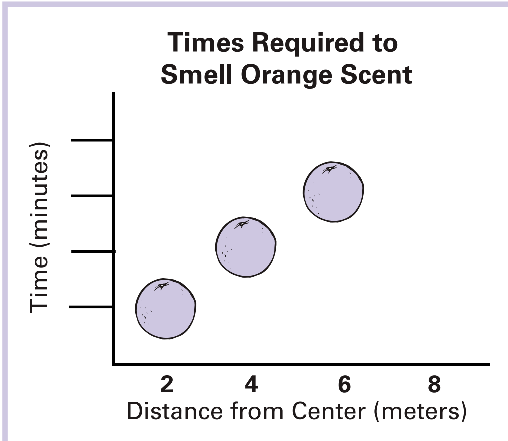
2. Stand in the center of the "wheel" holding the orange. Before you proceed, tell the students that they should raise their hands as soon as they smell the scent from the orange.
3. Begin to peel the orange, hold it in your hand and turn around slowly. Record (or have one or more students observe and record) the times when approximately three-fourths of the students at each distance have raised their hands.
4. On the board, create a graph showing the time it took for the group at each distance to smell the orange. (Leave the graph on the board until after you have conducted the outdoor portion of the activity.)
5. Use the graph to talk about odors traveling through the air. Ask questions such as, *Which group smelled the orange first? Which one smelled it last? Why do you think that happened?*

Part 2: Outdoors

1. Ask students, *What do you think will happen if we peel the orange outside? Will you smell it more quickly or more slowly?* Have students record their predictions.
2. Repeat steps 1 through 3 from Part 1 in an outdoor location.

Continued

3. After returning to the classroom, make a second graph, using the same scale as on the first, to show the time required for odors to travel outdoors. Compare the two graphs, and discuss differences. Ask, *In which environment did you smell the odor more quickly? Was the odor stronger in either place? Could everyone smell the scent in both locations? Why do you think that happened?* (In most cases, the scent will be noticed more quickly indoors. However, air currents indoors and breezes outdoors may affect the results. Discuss these variations with the class.)



Part 3: Compare and contrast
In a class discussion, relate this experiment to the movement of particles through air (see the activity, "Moving Air"), and lead students to understand how pollutants can become concentrated in indoor environments. Ask, *What do you think an odor is?* (It can be a gas or tiny particles of liquid floating in the air. Explain that many gases and particles float in air all the time.) Ask, *What happens when things floating in air get trapped inside a room? What if it were a harmful gas? How could pollutants in air enter our bodies?*

VARIATIONS

- About 30 minutes after finishing this activity, have students return to the outside location where they conducted their test. Ask, *Can you still smell the orange? What about inside the classroom? Is the orange scent still detectable?*
- Stand in front of a fan or other source of moving air while peeling the orange. Have students predict whether and how this will affect the distribution of orange scent in the room.
- Try this activity with different scents, such as those from perfumes, air fresheners, vinegar, etc.

QUESTIONS FOR STUDENTS TO THINK ABOUT

- Do different odors disperse at different rates?
- What are some things we could do to prevent harmful substances (for example, dust, chemicals, pollen) from building up inside our classrooms or homes?

11 Healthy Homes

Post-assessment

CONCEPTS
We are able to influence many aspects of indoor air quality.

OVERVIEW
Students will identify potential indoor air hazards at home and discuss ways they can be decreased or eliminated.

SCIENCE, HEALTH & MATH SKILLS
- Observing
- Recording observations
- Drawing conclusions
- Applying prior knowledge to a new situation

TIME
Preparation: 10 minutes
Class: 30 minutes for introduction of activity; 30 minutes to discuss students' observations and draw conclusions

MATERIALS
Teacher (see Setup):
- Overhead projector
- Transparency of student sheet (p. 50)

Each student will need:
- Copy of the pre-assessment he or she completed at the beginning of the unit
- Copy of "Healthy Home Survey" student sheet

We tend to forget that environmental problems are not restricted to outside habitats (natural or urban). Most people's homes, offices and schools are the "environments" in which we spend most of the day and night. Since we spend so much time inside, the quality of our indoor environments is very important.

Unit Links
Mr. Slaptail's Secret
Science boxes, pp. 28–29

Explorations
Worldly Words, p. 5

Indoor air can be polluted by many sources. Some indoor air pollutants are so irritating that they can bother anyone who breathes them. These include paints, asbestos fibers, smoke, cleaners, insect sprays and chemicals used on fabrics. Other pollutants can cause more problems for some people than for others. For example, some people are allergic to dust. When they breathe dusty air, people with dust allergies may start to sneeze, or experience runny noses and itchy eyes. Once in a while, dusty air can cause serious breathing problems, such as those associated with asthma.

How can we keep the air inside our homes and other buildings clean and safe to breathe? A little common sense goes a long way. We can be careful about using chemical cleaners, paints, glues and pesticides. Even better, we can use products that don't pollute. We can reduce the amount of dust in the air by regularly changing the filters in our home heating and cooling systems. We can eliminate some sources of indoor air pollution, such as tobacco smoke, completely.

SETUP
This activity should be introduced and summarized as a whole-class discussion. Students will work individually as they conduct their home air surveys.

PROCEDURE
Part 1. Getting started
1. Ask students to mention some things they have learned about indoor air. If you have used the Air unit's *Explorations* magazine and/or read the story, *Mr. Slaptail's Secret,* one or the other might serve as a basis for beginning a discussion. Otherwise, initiate a class review of different sources of indoor air pollution.
2. Mention that we can do many things to improve the quality of the air we breathe at home. Stress that before trying to solve problems of this type, we must look for possible sources of indoor air pollution. After those sources are identified, we can

Continued

decide which actions are needed to make improvements.
3. Give each student a copy of the "Healthy Home Survey" student page. Ask students to take their pages home and use them to conduct a survey of possible air pollutants inside their homes. Stress that an older family member or friend should help them conduct the survey. Students should circle or color different areas on their sheets in which they have found potential sources of indoor air pollution. Encourage them to draw any additional pollutants that they encounter during their surveys.

Part 2. Looking at results

1. Invite students to share their survey results with the class. Create a list on the board of different home air quality hazards identified, or make a transparency of the "Healthy Home Survey" sheet and make annotations while you project it as an overhead.
2. After the list is complete, have students suggest ways in which hazards can be decreased or eliminated. Do this as a whole-class discussion, or ask each student to write a paragraph about ways to improve indoor air quality.
3. Refer students to pages 28–29 of *Mr. Slaptail's Secret.* Ask them to find the different ways Mr. Slaptail's neighbors were able to eliminate air pollution inside his house.
4. Display the students' surveys.

Part 3. Post-assessment

1. Hand out students' pre-assessments, completed at the beginning of the unit. Ask students if there are any questions that they would answer differently now.
2. Have students use a different color ink to circle any new responses. On a separate sheet of paper, have students explain the reasoning behind their changes. Discuss students' new responses as a group.

VARIATIONS

- Conduct a "Healthy Home Survey" in your school building. Have students work in teams of 2–4 and assign teams to different parts of the building. Bring the class together to discuss students' observations and make a list of possible improvements. Be sure to identify measures already being taken to maintain a clean indoor environment in the building.

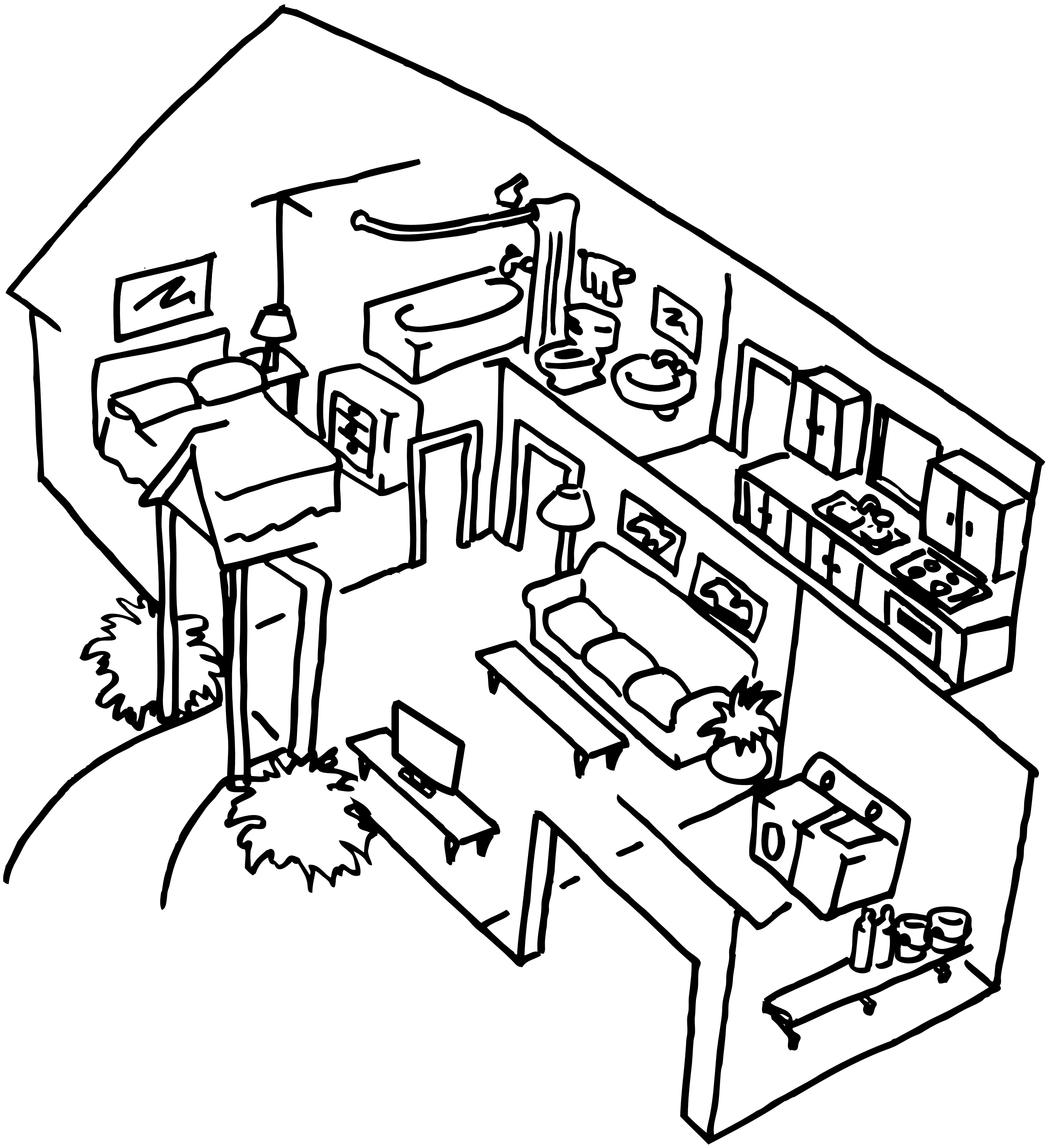
REDUCING INDOOR AIR POLLUTION

- Remove unnecessary "dust catchers," such as curtains.
- Store little-used things in plastic bags.
- Clean or change filters in heating and cooling systems frequently.
- Wash bedding in hot (at least 130° F) water to kill dust mites.
- Keep living and storage areas dry and well-ventilated.
- Store food leftovers in sealed containers to discourage cockroaches and other insects.
- Remove dust deposits with a damp sponge or cloth—especially when renovating.
- Ensure adequate ventilation when using products containing chemicals, such as those found in personal care or cleaning products.

Photo: CDC\11459\Dawn Arlotta, Cade Martin.

Healthy Home Survey

Encuesta de Casas Saludables



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