THE SCIENCE OF
Air

Moving Air

from *The Science of Air Teacher's Guide* and for *Mr. Slaptail's Secret*

Written by
Nancy P. Moreno, Ph.D.
Barbara Z. Tharp, M.S.
Judith H. Dresden, M.S.

BioEd℠
Teacher Resources from the
Center for Educational Outreach at
Baylor College of Medicine

Third edition. First edition published 1997.
Printed in the United States of America

ISBN: 978-1-888997-74-3

BioEd[SM]

Teacher Resources from the Center for Educational Outreach at Baylor College of Medicine.

Development of this unit was supported, in part, by grant numbers R25 ES06932 and R25 ES010698 from the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health (NIH). The opinions, findings and conclusions expressed in this publication are solely those of the authors and do not necessarily reflect the official views of Baylor College of Medicine, NIEHS or NIH.

Authors: Nancy P. Moreno, Ph.D., Barbara Z. Tharp, M.S., and Judith H. Dresden, M.S.
Editor: James P. Denk, M.A.
Designer and Illustrator: Martha S. Young, B.F.A.

ACKNOWLEDGMENTS

The Science of Air educational materials, first developed as part of the My Health My World® project at Baylor College of Medicine, have benefited from the vision and expertise of scientists and educators representing a wide range of specialties. Our heartfelt appreciation goes to Michael Lieberman, M.D., Ph.D., William A. Thomson, Ph.D., and Carlos Vallbona, M.D., who have lent their support and expertise to the project.

Special acknowledgment is due to our original partners in this project, the Texas Medical Association and the American Physiological Society (APS). We especially thank Marsha Lakes Matyas, Ph.D., of APS, for her direction of field test activities and ongoing collaboration.

Several colleagues provided valuable assistance during the development of this guide. In particular, we would like to thank Zenaido Camacho, Ph.D., Cynthia Jumper, M.D., Fabiola Pineda, M.S., Ronald Sass, Ph.D., and Cathey Whitener, M.S.

Special thanks go to the National Institute of Environmental Health Sciences, Allen Dearry, Ph.D., Frederick Tyson, Ph.D., and Liam O'Fallon for their support of the My Health My World project and the related Environment as a Context for Opportunities in Schools (ECOS) project.

We are especially grateful to the many classroom teachers in Washington, D.C., and Houston and Austin, Texas, who participated in the field tests of these materials and provided invaluable feedback.

BCM
Baylor College of Medicine

Center for Educational Outreach
Baylor College of Medicine
One Baylor Plaza, BCM411
Houston, Texas 77030
713-798-8200 | 800-798-8244 | edoutreach@bcm.edu
www.bcm.edu/edoutreach | www.bioedonline.org | www.k8science.org

Baylor College of Medicine
www.bcm.edu

BioEd Online
www.bioedonline.org

Center for Educational Outreach
www.bcm.edu/edoutreach

Centers for Disease Control and Prevention
Public Health Image Library
http://phil.cdc.gov/phil

Frank R. Segarra
www.flickr.com/photos/fsegarra

K8 Science
www.k8science.org

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

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

The Air Around Us

Physical Science Basics

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.

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

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):

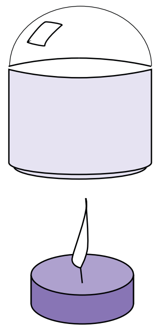
- 1 liter of cold water (or ice cubes)
- 1 liter of warm tap water
- 1 liter of room temperature water
- 1 tea candle and matches, hotplate, warming tray or warm towel
- Dishwashing liquid and glycerin for bubble solution

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



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.

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.

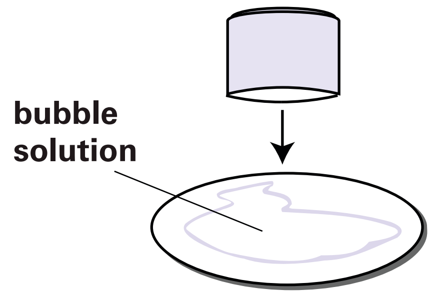
3. Demonstrate how to tip the open end of a can in the bubble solution to create a thin film. Have students predict what might happen to bubble film when the can is placed in room temperature, warm and cold water. They should draw their predictions on their student sheets. Have students dip the open 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?*

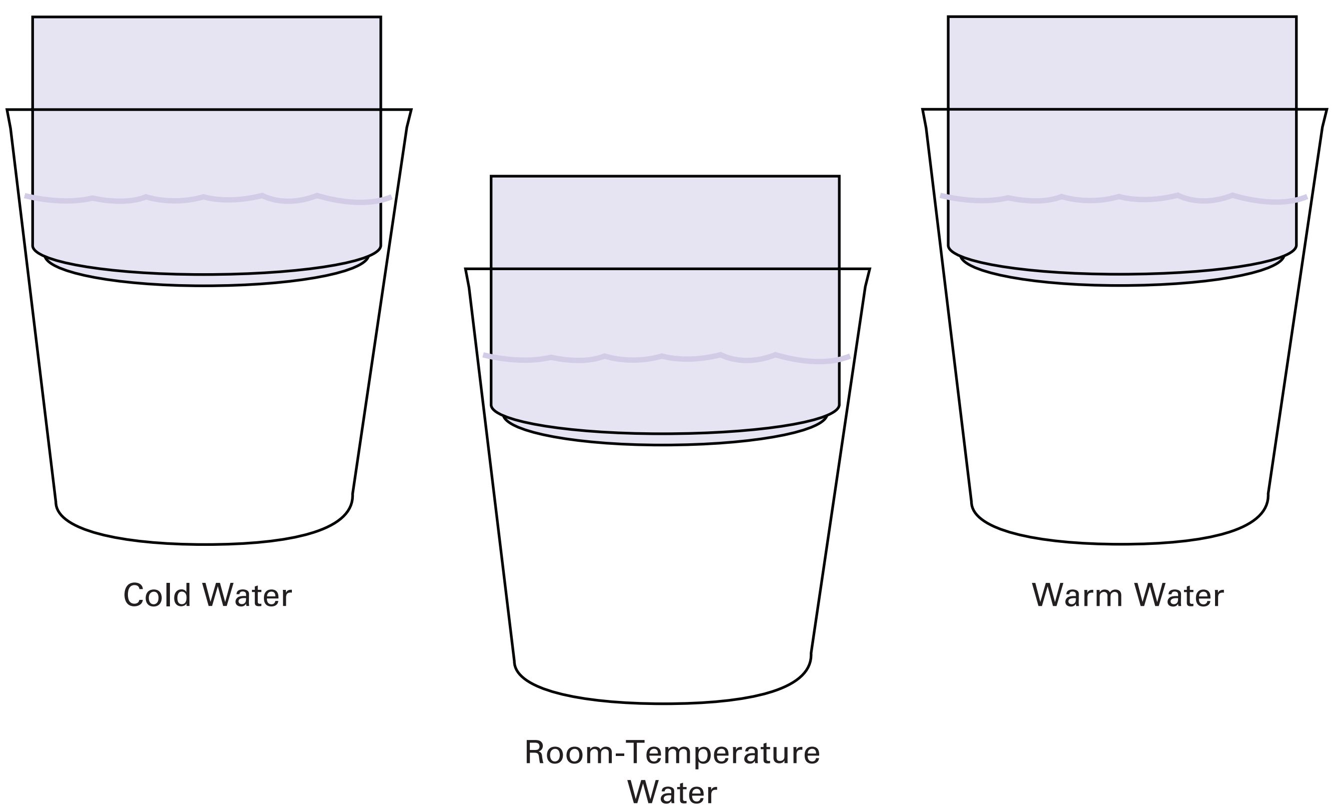
VARIATIONS

- 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.)

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.