Gases Matter

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

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The activities described in this book are intended for school-age children under direct supervision of adults. The authors and Baylor College of Medicine cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text.

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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.

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.

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.

Gases Matter

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 the activity, "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

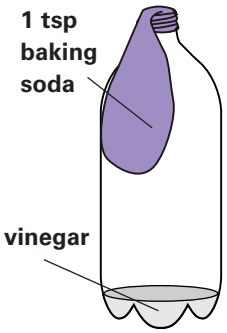
Always follow district and school science laboratory safety procedures. It is good practice to have students wash hands before and after any laboratory activity. Clean work areas with disinfectant.

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.

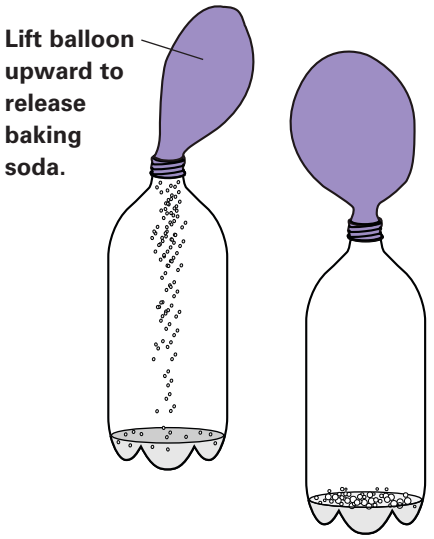
SOLID TO GAS

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

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.