Research scientists setting up one of NASA's long-duration balloon missios. Photo courtesy of NASA/Matt Truch.

Gases Matter

The Science of Air: Activity 2

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Gases Matter

This activity's objectives are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Physical Science. "Gases Matter" uses guided inquiry to provide a basic introduction to the study of gases. Students will explore gases by observing a balloon inflate. They also will draw the conclusions that the balloon contains air and that air is a mixture of gases. Specific science concepts addressed in this activity include the following.

Concepts

- Air is made up of gases.
- Gases take up space.
- Carbon dioxide is a gas. .

Reference

Moreno N., B. Tharp, and J. Dresden. (2011). *The Science of Air Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-74-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Image Reference

Photo courtesy of NASA/Matt Truch. http://stratocat.com.ar/fichas-e/2011/MCM-20110109.htm

Key Words
lesson, teaching slides, gas, gases, nitrogen, oxygen, carbon dioxide, air, indoor air, atmosphere, air pollution, science, life science, biology, environment, environmental science, health,

Materials

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Materials

Teacher Materials

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

Reference

Moreno, N., B. Tharp, and J. Dresden, J. (2010). *The Science of Air Teacher's Guide.* Third edition. Baylor College of Medicine. Development of this activity was funded, in part, from the National Institute of Environmental Health Sciences of the National Institutes of Health, grant numbers R25 ES10698, R25 ES10698S, and R25 ES06932.

Image Reference

Photo by Christopher Burnett © Baylor College of Medicine.

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Science Safety Considerations

Safety first! Students always must think about safety when conducting science investigations. This slide may be used to review safety with your class prior to beginning the activity.

Also, keep the following points in mind.

- Always follow your district school safety guidelines.
- Have a clear understanding of the investigation in advance. Practice any investigation with which you are not familiar before conducting it with the class.
- Make sure the appropriate safety equipment, such as safety goggles, is available.
- Continually monitor the area where the investigation is being conducted.

References

1.Dean, R., M. Dean, and L. Motz. (2003). *Safety in the Elementary Science Classroom*. Arlington, VA: National Science Teachers Association.

2.Moreno N., B. Tharp, and J. Dresden. (2011). *The Science of Air Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-74-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

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What's In the Balloon?

- Have you ever wondered what's inside an inflated balloon?
- Touch the sides of the balloon. How does it feel?
- Can we see air?
- What are the components of air?

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What's Growing On Your Bread?

To focus your students' attention, begin by asking, "Can we see gases?" Then, to demonstrate that it is possible to observe gases, blow up a large balloon in front of your students. Allow students to touch the sides of the balloon.

Begin a class discussing by asking, "What do you think is inside the balloon?" Lead students to the conclusion that the balloon contains air. Explain that air consists of a mixture of gases that we cannot always see or smell.

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Image Reference

Balloons courtesy of Petr Kratochvil, released into the Public Domain. http://www.publicdomainpictures.net/view-image.php?image=5427

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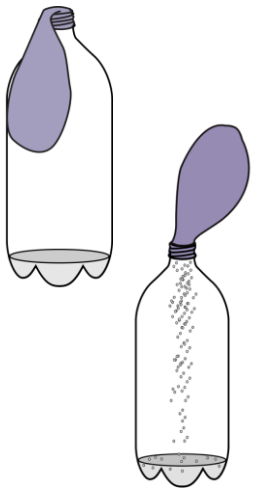
Let's Get Started

1. Add 3 tablespoons of vinegar to the 2-liter soft drink bottle.
2. Put 1 teaspoon of baking soda into the deflated balloon.
3. Fasten the balloon over the mouth of the bottle without letting the baking soda fall into the bottle.
4. Lift the balloon upward and let the baking soda fall into the vinegar.
5. Observe what happens,



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Let's Get Started

In this activity, students will observe how the production of carbon dioxide can cause a balloon to inflate. They will predict what is inside the balloon after two components (vinegar and baking soda) are mixed together in the soft drink bottle to which the balloon is attached. They will determine that a gas (carbon dioxide) is inside the balloon.

Conduct this activity as a discovery lesson with the entire class. Ask students to observe as you place a few tablespoons of vinegar in the bottom of the soft drink bottle. Next, use a creased note card or sheet of paper to slide 1 teaspoon of baking soda into a balloon (use a different balloon from the previous demonstration). Securely fasten the balloon over the mouth of the bottle, being careful not to let any baking soda fall into the bottle. Once the balloon is secured in place, have the students observe carefully as you lift the balloon gently upward, dropping the baking soda into the vinegar at the bottom of the bottle.

The ensuing chemical reaction should produce bubbles or foam, along with a gas that inflates the balloon. Students will see the balloon expand as it fills with carbon dioxide produced by the chemical reaction between vinegar and baking soda. If the balloon does not inflate, ensure that it is securely fastened to the top of the bottle and gently shake the bottle to mix the vinegar and baking soda.

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Image Reference

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

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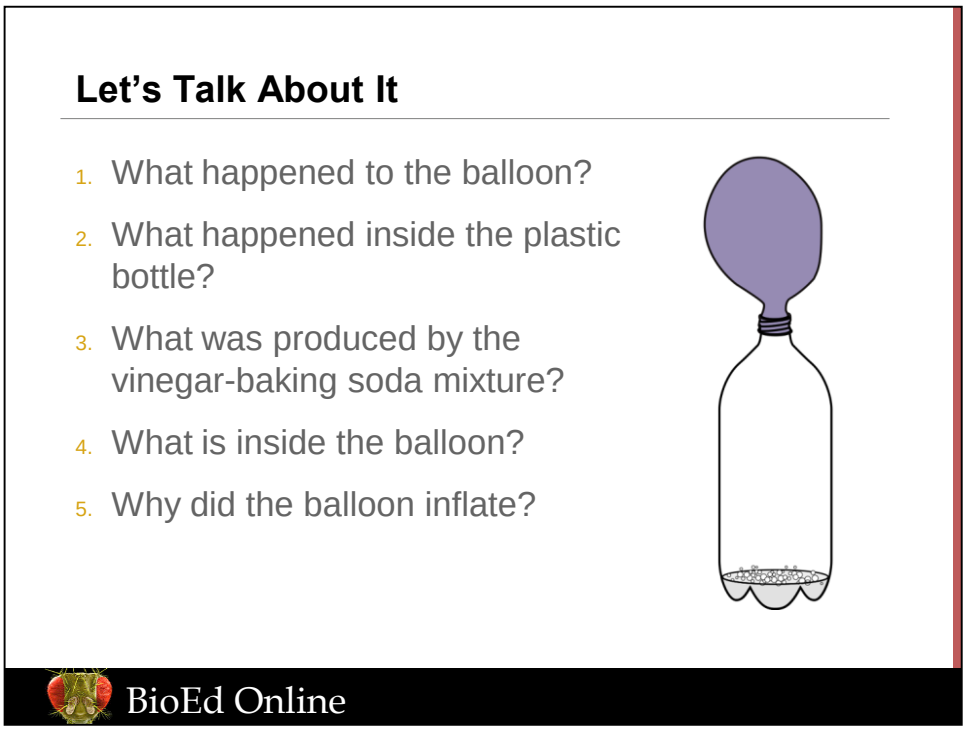

Let's Talk About It

This demonstration provides a basic introduction to the concept of gases. Students discover that even though we cannot see or smell many gases, it is possible to observe them. For example, gases put pressure on the walls of containers such as balloons, balls or tires.

Stimulate a discussion about what happened to the balloon after the vinegar and baking soda were mixed. Challenge students to offer their best explains about why the balloon expanded. During this class discussion, expect a variety of answers and observations. In response, pose questions that may point students in the right direction and encourage them to think. For example, ask, "What happened to the balloon. Did it expand, or inflate? How much did it inflate? What did you see happening in the bottom of the bottle? Why did the balloon inflate?" You may want to mention that a chemical reaction occurred.

Help students to understand that carbon dioxide also is produced as a waste product by most living cells.

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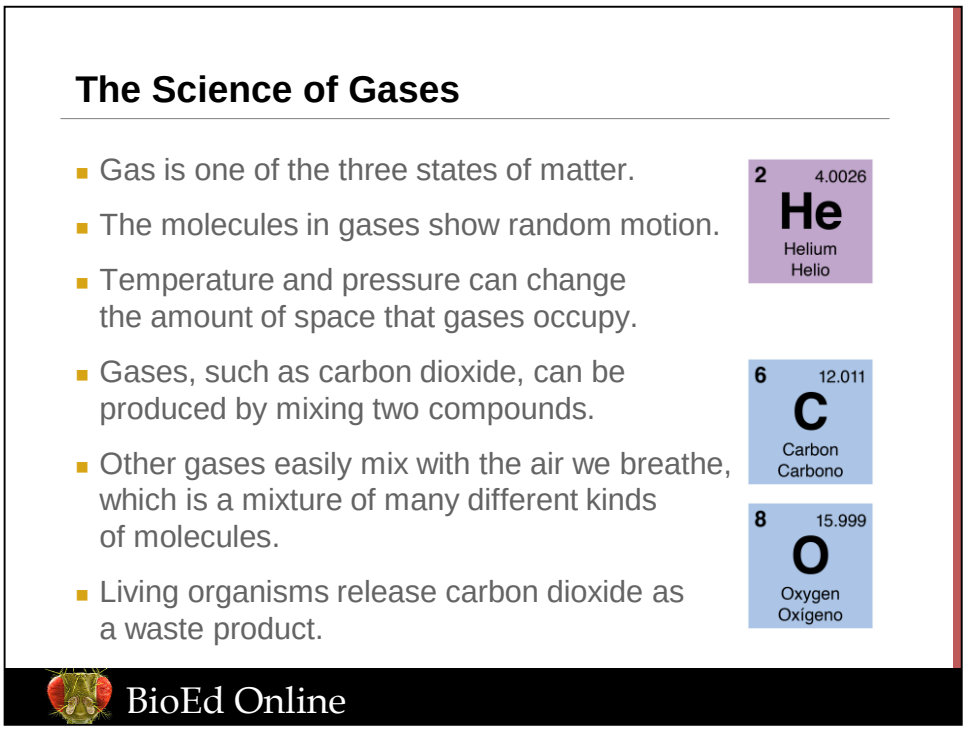

The Science of Gases

During the conduct of this activity, students observed the following properties.

- **Gases take up space**. Gases are one of the three basic states of matter (the other two are liquids and solids). Gases take up space, but unlike liquids or solids, they have no definite shape or volume unless they are placed into a container. In this activity, students observed that gases take up space (they saw the balloon inflate). The molecules in gases freely move randomly and are more or less evenly distributed. Changes in temperature and pressure can change the volume, or how much space, gases fill. For example, an increase in temperature will cause gases to expand and rise. However, an increase in pressure will cause gases to contract.
- **We cannot see or smell many kinds of gases**. For example, the air we breathe is made of a mixture of gases that we cannot see or smell. At the same time, some gases have odors.
- **Gas can be produced by mixing two compounds**. Vinegar is a weak acid (acetic acid) and baking soda also is known as sodium bicarbonate. In this activity, vinegar and baking soda were mixed together to produce a chemical reaction that released carbon dioxide. The carbon dioxide filled up the plastic bottle and inflated the balloon. Explain to students that living organisms, including humans, also release carbon dioxide, which is released from our bodies when we breathe out. The carbon dioxide produced in our bodies also comes from chemical reactions.

Note:

Carbon. Atomic number = 6. Atomic weight = 12.011. Standard atomic weight based upon ^{12}C.

Oxygen. Atomic number = 8. Atomic weight = 15.999. Standard atomic weight based

upon ^{12}C.

Reference

1. Moreno N., B. Tharp, and J. Dresden. (2011). *The Science of Air Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-74-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.
2. Standard measurements courtesy of the National Institute of Standards and Technology, U.S. Department of Commerce.

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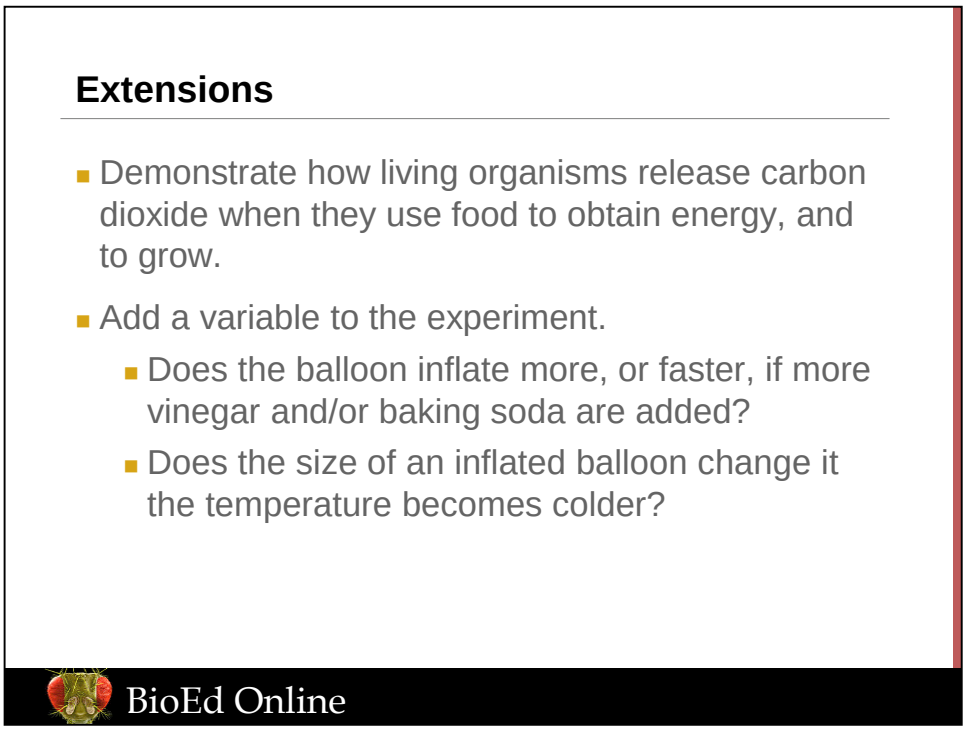

Extensions

Older students may enjoy working in small groups to mix the compounds to produce carbon dioxide themselves. When conducted by students, this activity will take about 30 minutes to complete. To conduct 6 small group activities, you will need the following materials: 6 plastic soft drink bottles, 6 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, or to grow or reproduce, place one tablespoon of dry yeast, one teaspoon of sugar, and 1/4 cup of warm water in a plastic soda bottle. Mix these ingredients 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 inflate as the yeast cells become active, use the sugar for food, and release carbon dioxide.

Ask students to suggest variations of the carbon dioxide investigation. They may wish to investigate, for example, the effect of temperature on the size of the inflated balloon. To conduct this experiment, blow up a balloon and tie the end. Use a flexible tape measure to measure the balloon's circumference at its widest part. If you do not have a flexible tape measure, you can simply measure the balloon's width with a ruler. Next, gently submerge the inflated balloon in a bucket of ice cold water. After several minutes, remove the balloon from the water and quickly measure its circumference or width, as appropriate. The balloon should have decreased in size. Explain that lower temperatures cause gases to apply less pressure against the sides of a container, because their movement has slowed.

Students also may want to investigate how much more or less the balloon inflates if they add twice as much vinegar and baking soda to the mixture in the soda bottle.

Have students make the cylinder flyer described in the story, *Mr. Slaptail's Secret* (directions are provided at the end of the book). Talk about what supports or holds up the flyers as they soar through the air.

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