Though we cannot see gases, it is possible to observe them in other ways. Photo © Eskay Lim. Licensed for use.

Moving Air

The Science of Air: Activity 4

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Moving Air

This activity's objectives are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Physical Science. Moving Air uses guided inquiry to illustrate that the warming or cooling of a small amount of air will change the amount of space that it can occupy inside a bubble. Students will make predictions, investigate, record observations, and draw conclusions based on their investigations.

Concepts

- At higher temperatures, air molecules are more active, take up more space, and push harder against the sides of a container.
- At lower temperatures, air molecules are less active, take up less space, and exert less force against the sides of a container.

Reference

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Image Reference

Key Words
lesson, teaching slides, lesson demonstration, physical science, air, atmosphere, air temperature, heat, gas, gases, nitrogen, oxygen, argon, carbon dioxide, ozone, molecules, air particle

Materials

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Materials

Teacher Materials

Dishwashing liquid and glycerin for bubble sollution
Liter of ice water (cold water containing ice cubes works best)
Liter of warm tap water
Liter of room temperature water
Tea candle and matches (a hotplate, warming tray, or warm towel also will work)

Materials per Student Group

- Bottom half of one aluminum soft drink can (see Teacher Setup below)
- Shallow bowl containing bubble solution
- Wide-mouth plastic cup (9-oz. size) half-filled with warm tap water
- Wide-mouth plastic cup (9-oz. size) half-filled with ice water (include a few ice cubes)
- Wide-mouth plastic cup (9-oz. size) half-filled with room temperature water
- Red crayon or marker
- Blue crayon or marker
- Safety goggles for each student in the group
- Copies of “My Observations” worksheet

Setup

1.Prepare aluminum soft drink cans: 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.) Be sure that the cut edges of the can are smooth or covered with tape, so students do not injure themselves.

2. Prepare bubble solution: If you do not have commercial bubble solution, you can easily make your own by mixing together 1 gallon of water, 1 cup of dishwashing liquid, and ¼ cup of glycerin (from the drugstore).

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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 appropriate safety equipment, such as safety goggles, is available.
- Continually monitor the area where the investigation is being conducted.

Reference

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

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How Does Air Behave?

- Does temperature affect air's behavior?
- Have you ever wondered how hot air balloons fly?
- How hot is the air in hot air balloons?

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How Does Air Behave?

Focus students' attention by asking, *Is it hot or cold outside? Do you know that the temperature of air affects how it behaves and what it can do?* Explain that temperature affects how fast air molecules move and how much space air takes up. You may wish to stimulate further conversation by asking, *Can you think of any other ways temperature changes the way air behaves?*

Have students predict whether air will sink or rise if it is warmed. Write their predictions on the board, and then ask, *Have you ever wondered how hot air balloons fly?*

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Image Reference

Photo © Randy Oostdyk, CC-BY-SA 3.0. http://en.wikipedia.org/wiki/File:Ballon2.jpg.

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Let’s Get Started

- Collect materials.
- Draw a red line on the student sheet to indicate where you think the bubble will be when the can is put in water of each different temperature.
- Dip the open end of the can into bubble solution.
- Place the can into the ice water and examine what happens to the size of the bubble.
- Record results in blue on the “My Observations” worksheet.
- Repeat the process using room temperature and warm water.

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Let’s Get Started

In this activity, students will observe how the temperature of air can change the size of soap/glycerin bubbles. They will make predictions, record observations, and draw conclusions based on their investigations. Students will learn that high temperatures cause air to expand and take up more space (when held in an expandable container), while cold temperatures cause air to contract and occupy less space.

Divide students into small groups. (If your students are very young, you may prefer to conduct the activity as a discovery lesson with the entire class.) Ask Materials Managers to collect the materials for their groups.

Demonstrate how to dip the open end of a can into the bubble solution to create a thin film. Have students predict what might happen to the bubble film when the can is placed in ice water, water at room temperature, and warm water. Students should use a red crayon to record their predictions on the My Observations worksheet. Then, have students dip the open ends of their cans into bubble solution. A film of solution will be visible across the tops of their cans.

Direct each group to place its can in the cup containing ice water and observe the bubble film for about a minute. Ask, “What is happening to the bubble?” and “What does this tell us about the air inside?” Have students use the blue crayon to record their observations on the “My Observations” worksheet.

Then, direct students to make a new bubble film and repeat the above steps to observe the effects of room temperature and warm water on the bubble.

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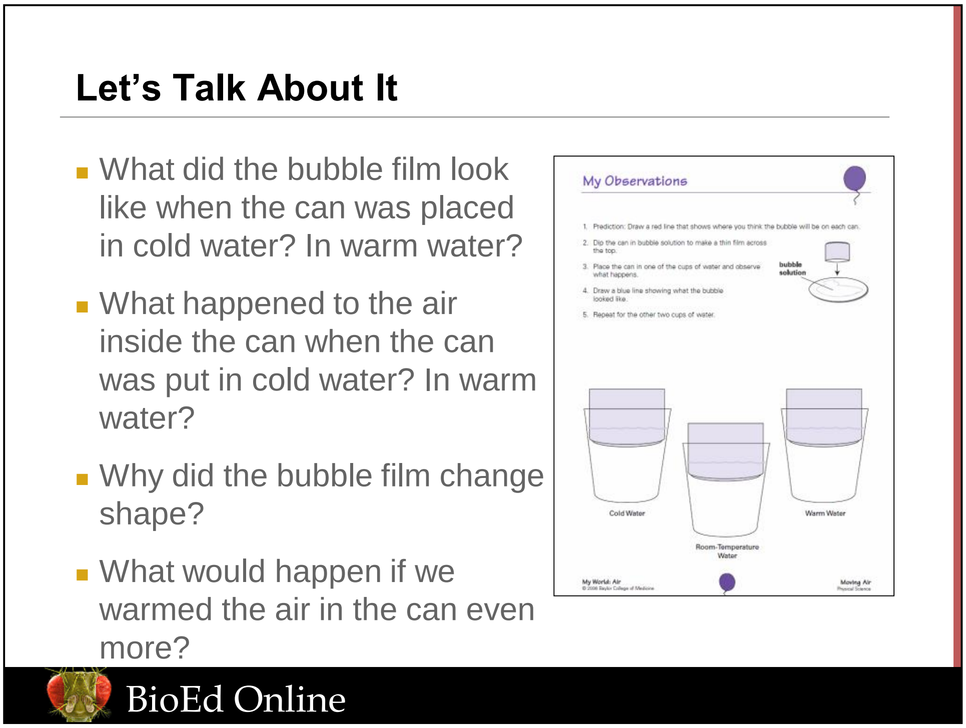

Let's Talk About It

As a class, discuss students' predictions about the effects of warm and cool air on their bubbles. Then talk about what actually happened.

Tell students that temperature determines how much the molecules in air move and how much space air can take up. Ask students, *Why did the bubble film dip below the top of the can when you placed the can in ice water?* Be sure that the students understand the ice water cooled the molecules in the air, which caused the molecules to move less and push less against each other and the sides of the container than they did in warmer air. Continue the discussion by asking students to explain what happened to the bubble film when the can was placed in the warm water. In this case, students should understand that when the molecules in the air were warmed by the water, they moved more and bounced more against each other and against the bubble top of the container than they did when the air was cooler.

Next, ask students, *What do you think will happen if we heat the air in the can even more?* As a class demonstration, dip the open end of another can in bubble solution, and then heat the bottom of the can using a lighted candle or hotplate. The bubble will bulge much more dramatically than when the can was placed in warm water.

Extend students' discoveries about the movement of air by encouraging students to think about what might be happening with the air inside the classroom right now. Ask, *What happened to the air inside the can when it was placed in cold water? In warm water?* Begin a general class discussion by asking*, Is all the air in this room the same temperature? If not, what are the sources of different temperatures of air? What will happen if the air in one part of the room is warmer than air in another part of the room?*

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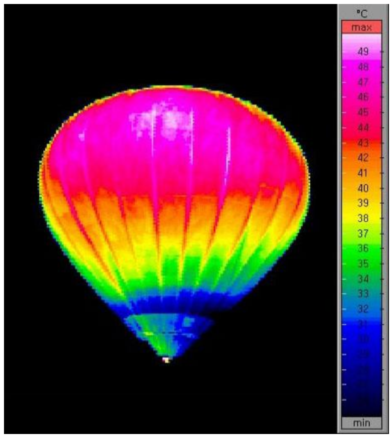
The Science of Air and Temperature



In this thermographic image of a hot air balloon, the color pink reflects the lowest temperature in the balloon, while deep blue represents the hottest temperature.

- Temperature determines how much the molecules in air move.
- Temperature determines how much space air occupies.
- Temperature changes account for most air movement that we can observe, both indoors and outdoors.

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The Science of Air and Temperature

In this activity, students observed the following properties of air.

- **Temperature determines how much the molecules in air move**. The molecules in air (and in all gases) are constantly moving in a random motion. As temperature rises, molecules become more active. They bounce off one another and off the sides of a container with more energy. At lower temperatures, there is less motion and energy among molecules.
- **Temperature determines how much space air occupies**. Gases take up space, but unlike liquids or solids, they have no definite shape or volume unless they are put into a container. The amount of space occupied by a gas is determined by temperature. For example, an increase in temperature causes air to expand and rise (due to more energetic "bouncing" of air molecules). A decrease in temperature will cause air to contract (take up less space), and sink.
- **Temperature changes account for most air movement that we can observe, both indoors and outdoors**. In a room with areas of different temperatures, air currents will develop as higher-energy ("bouncier") warm air rises and lower-energy cool air sinks. For example, consider the following situations.
    1. Opening the freezer or refrigerator door allows cold air to escape and travel down to the floor.
    2. A bedroom upstairs is warmer than the bedroom below it because warm air rises.
    3. A hot air balloon rises because hot air inside the balloon lifts it off the ground. In the infrared image on this slide, pink indicates very hot air temperatures inside the balloon; blue indicates cooler air. Notice that the hottest air is at the very top of the balloon, while the cooler air is at the bottom.

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Extensions

- Blow bubbles in the air and watch where they travel.
- Do differences in temperature affect the distribution of dust and other pollutants within a room?
- How do temperature differences affect air movement on Earth?

In the image above, moving clouds reveal air movement around the Earth.

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Extensions

Have students use bubbles to study air movements in other ways. For example, have them gently blow bubbles up into the air and observe where the bubbles travel. Ask, “Do the bubbles eventually fill the room?” and “Do they move upward or downward?”

Differences in temperature cause air movement. Have students predict how variations in air temperature would affect the distribution of dust and other pollutants within a room or building.

Have students look at a map or globe. Explain that the sun heats air near the equator more than it heats air near the poles (the poles receive less direct heat from the sun). Ask, *How do you think these differences in temperature influence the movement of air on Earth?* Then show students a chart of global wind patterns, such as the one on this slide, which shows prevailing wind circulation on Earth (indicated by the white arrows). Be sure to point out how wind patterns vary at different locations.

Experiment

Blow up a Ziplock® bag (1 gallon size) until it is fully inflated and the sides are tense. Do this by “unzipping” the bag slightly, blowing in, and closing it quickly without letting air out. Let the bag sit for 5–10 min. During this time, the air in the bag will cool from your body temperature (98.6 ºF) to room temperature (68–77ºF). This drop in temperature will cause the air in the bag to contract and exert less pressure on the sides of the bag. Thus, over time, students will notice that the sides of the bag become less taut. For a more dramatic display of the contraction of air at cooler temperatures, blow up a second Ziplock® bag and place it in the freezer for 5–10 min. Then compare this bag to the one at room temperature.

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Image Reference

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http://commons.wikimedia.org/wiki/File:Fullsdisk_sept_2_2010_1745Z.jpg

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