AIR ON THE RISE
EXPLORATION

Bubbles on Bottles

Students observe that a change in the temperature of air can impact the size of a bubble placed on a bottle that is cooled and/or heated.

What you'll need:
For each pair of students:
- 2 clear plastic 1 liter bottles
- plastic shoe box or similar
- small plastic containers
- hot water in an open top kettle
- ice water
- dishwashing soap - diluted

Directions: (this can be altered to a format that best fits the activity when necessary)
Intro to directions followed by steps in both instructions and the activity:
1. File a clear plastic shoebox with 3"-5" of ice water for each group of two to four students (have hot water on standby to fill a shoebox container in the same way for each group).
2. Add approximately 1/4" of diluted dishwashing soap to a small container for each group.
3. Demonstrate dipping the narrow open end of the bottle (mouth) into the soap container to form a film over it, then have students practice this. If the film pops, simply ask students to repeat the procedure.
4. Next place the bottom of the bottle into the cold water. Have students record what happens.
5. Carefully provide a shoebox with 3" - 5" of hot water in it to each group, making sure to review common safety precautions.
6. Have students experiment and record what happens when the bottom of a bottle with soap film over its mouth is placed in the hot water.
7. Encourage students to place their bottle in both the hot and cold water without breaking the bubble to see it rise and fall due to the temperature change.

Reflection and Assessment
Ask the students the following questions:
1. Is the same amount of air in the bottle if the bubble does not pop?
2. Is the volume of air increasing or decreasing in the bottle when it is warmed? What happens when the air is cooled?
3. What could you do to make the bubble grow larger or smaller? Do you know?

Background Information
Convection is the transfer of heat by the movement or flow of a substance from one position to another. Temperature is a measure of the average speed or kinetic energy of molecules. These are both demonstrated in this activity, as changes in the tempertature of air inside the bottle makes the air's volume grow or shrink. The warm bath causes the air inside the bottle to warm and expand, thus increasing the volume that the air needs. The air pushes the bubble up above the bottle's mouth. The cold bath creates a slower and consequently more densely packed air mass that sinks into the bottle, pulling the bubble inside the bottle's neck. As the temperature in the bottle fluctuates between cold and warm, the bubble serves as a tracer of invisible air – showing students how the mass of air in the bottle remains the same, but the space it takes up (its volume) changes as a result of its temperature.

For Teachers:

Student Learning Objectives
Students will:
- learn that air's volume changes with temperature
- learn that air can both expand and contract depending on if its temperature increases of decreases

Class time
- 30-45 minutes

Grades
- K - 4th grade

National Science Standards
- A: Science as Inquiry
- D: Earth Science

Developed by Teri Eastburn, UCAR Center for Science Education

Older students and others needing to solve for mass, density and volume use the following equations:

Mass = Density x Volume (M=DV) Density = $\frac{\text{Mass}}{\text{Volume}}$ (D = M/V) Volume = $\frac{\text{Mass}}{\text{Density}}$ (V = M/D)

Related Web Pages for Students

- http://eo.ucar.edu/webweather/
- http://eo.ucar.edu/kids/sky/index.htm
- http://www.ucar.edu/learn
- http://SciEd.ucar.edu