Soda and Celsius: An Experiment with Heat and Temperature Using Carbonation
Lesson Plan

Grade Level: 6-8	**Curriculum Focus:** Heat	**Lesson Duration:** Two class periods

Student Objectives

- Understand relationship between temperature and pressure.
- Collect data and graph the relationship between pressure and temperature.
- Compare the information collected between both Fahrenheit and Celsius temperature scales.

Materials

- Discovery School video on *unitedstreaming*: *Heat and Temperature*
  Search for this video by using the video title (or a portion of it) as the keyword.

  Selected clips that support this lesson plan:

  - The Thermometer
  - Temperature
  - The Fahrenheit Scale

For each lab group:

- Two Celsius and two Fahrenheit thermometers (0.1 degree increments preferred)
- Two clear, plastic, 20-ounce bottles of carbonated soft drink at room temperature
- Two 2-hole rubber stoppers (the right size to fit the opening of the soft drink bottle used in this study)

For each student:

- One Temperature and Data Chart (see Procedures)
- Two pieces of graph paper, one to chart Celsius measurements and one to chart Fahrenheit
- Ruler

Procedures

1. Divide students into small lab groups. Explain that they will be collecting data on the relationship between pressure and temperature. Give each lab group the materials listed above.

Each student should have a copy of the following Temperature and Data Chart to record her or his findings:

Temperature and Data Chart

Pressure (no. of shakes)	Temperature in degrees C (Bottle no. 1)	Temperature in degrees F (Bottle no. 2)
0 (beginning of experiment)		
2		
4		
6		
8		
10		
12		
14		
16		
18		

2. Briefly explain the experiment. Students will be shaking a half-full carbonated drink to increase the pressure within the bottle. They will shake it twice, four times, six times, and so on, recording the change in temperature after every two shakes. Students will be performing this experiment two times, first using a Celsius thermometer and a second time using a Fahrenheit thermometer. They will be recording the data on their data sheet, then creating graphs with the recorded data.
3. Make sure to follow proper safety precautions and guidelines outlined in science texts. Have students carefully insert one of the Celsius thermometers into one hole of a two-hole rubber stopper. Push the thermometer until 2 to 3 inches of it extend below the stopper bottom.
4. Note the room temperature. Now gently open one of the carbonated soda bottles. Try to lose as little of the carbonation in the liquid as possible. Insert the second Celsius thermometer into the carbonated drink to determine if the soda is at room temperature. It is important for the purposes of this lesson that the soda is at room temperature before the experiment begins. Remove thermometer and set aside.
5. Now slowly pour out half the beverage. Again, try not to lose any of the carbonation.
6. Carefully insert the rubber stopper with the thermometer into the top of the bottle of soda. Make certain the stopper is seated firmly in place and the thermometer tip *is not* touching the liquid inside the bottle. Observe and record the temperature of the thermometer on the Temperature and Pressure Data Chart.

7. Firmly cover the second hole of the rubber stopper with one finger. Pick up the bottle of soda and vigorously shake it *twice only*. Set the bottle on a flat surface and observe and record the temperature on your Temperature and Pressure Data Chart. IMPORTANT: Be sure to *keep your finger over the second hole of the rubber stopper* so you do not lose any pressure built up inside the bottle.
8. Pick up the bottle once again and shake it two more times. As before, make sure you do not remove your finger from the second hole. Place the bottle on a flat surface and observe and record the temperature. Continue to shake the bottle twice and observe and record temperature until no further increase is observed. Carefully and slowly remove your finger from the covered hole of the rubber stopper.
9. Have students open the second bottle of soft drink and repeat steps 3 through 8 using a Fahrenheit thermometer. It is important to use a new bottle because of the loss of carbonation during the Celsius measurement.
10. When they have finished gathering their experimental data, pass out two sheets of graph paper to each student so she or he may begin plotting her or his data. Explain that students will create one graph to represent pressure and Celsius data, and one for pressure and Fahrenheit observations.
11. Have students graph their data by labeling the x-axis on their graph with the number of shakes of the soda bottle, representing pressure. Have students label the y-axis on their graph with degrees. (One graph will show degrees Celsius and the second graph will show degrees Fahrenheit.) Make sure the graph fills as much of the page as possible and that students title their graph.
12. Ask students to plot the data points from their data tables on their graphs and draw a line connecting the points.
13. Analyze the results of Celsius and Fahrenheit data sheets and graphs. What is the relationship between pressure and temperature? How did the results of the Fahrenheit and Celsius data sheets compare?

Discussion Questions

1. Which results had a greater number of degree temperature changes in your lab: the Celsius or Fahrenheit measurements? Does this have any effect on the resulting graphed data? Why?
2. How might the amount of beverage in the container have an effect on temperature changes during this exercise? Would the type of carbonated beverage have an impact on the results? Why or why not?
3. Consider the concept that pressure, volume, and temperature are all related. What can be concluded about this relationship based on the lab just completed?
4. Consider the concept that an increase in pressure causes an increase in temperature. How does this relate to the making of a snowball?

5. Ice skates work because of the same principle—an increase in pressure causes the temperature to increase. Explain what actually happens to the ice at the point of contact between the ice skate blade and the ice itself. Is it possible that ice could be so cold that ice-skating would not be possible? Explain.
6. Why don't basketballs feel warm? After all, they contain air under pressure.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Student contributed to his or her lab group; collected accurate, clear data for each experiment; created an accurate, neat graph; drew logical conclusions based on the evidence.
- 2 points: Student contributed somewhat to his or her lab group; collected complete data for each experiment; created a satisfactory graph; drew conclusions, loosely based on evidence.
- 1 point: Student did not contribute to his or her lab group; collected inaccurate data for each experiment; created an incomplete graph; had difficulty drawing conclusions based on evidence.

Vocabulary

carbonate

Definition: To charge (a beverage, for example) with carbon dioxide gas.

Context: Soft drinks are often carbonated, giving them a fizz when poured into a clear container.

control

Definition: An individual or group in an experiment for which the procedure or agent being tested is omitted; this group is then used as a standard to compare the results of the other groups.

Context: In this experiment we need a control group with which to compare our results.

density

Definition: The quantity of something per unit measure, especially per unit length, area, or volume.

Context: One difference between lead and aluminum is that lead has a higher density than aluminum.

pressurize

Definition: To confine the contents of a pressure greater than that of the outside atmosphere.

Context: The air inside a car tire needs to be pressurized to the proper level for the best level of handling and wear.

Academic Standards

Mid-continent Research for Education and Learning (McREL)
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit
http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Physical Science: Understands the sources and properties of energy.

National Academy of Sciences
The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site:
http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Physical Science: Transfer of energy

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html