UNDER PRESSURE

Science Concept:

Air pressure is a force.

Objectives:

The student will:

- describe how changing pressure causes air to expand or contract;
- make predictions about the effects of temperature on air pressure; and
- diagram the force of air pressure acting on an object.

GLEs Addressed:

Science

[7] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by describing the weather using accepted meteorological terms (e.g., pressure systems, fronts, precipitation).

[7] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

Writing

[7] W3.2.4 The student writes for a variety of purposes and audiences by using diagrams, charts or illustrations with captions or labels in research projects or extended reports*(L)

Vocabulary:

atmosphere – the gaseous envelope surrounding Earth; the air

force – an influence on a body or system, producing or tending to produce a change in movement or in shape or other effects

pressure – the exertion of force upon a surface by an object, fluid, etc., in contact with it; the pressure of earth against a wall

Materials:

- Aluminum soda can, empty
- Hot plate or Bunsen Burner w/ring stand, ring, and gauze pad
- Shallow aluminum pie pan
- Tongs (beaker tongs work best)
- Safety goggles (one pair per student)
- Clear storage tub, 12-quart size (one per group)
- Beaker or clear acrylic juice glass, 200 milliliters (one per group)
- Straw, flexible (one per group)
- Food coloring, red or other dark color (three to four drops per group)
- Lab notebook (one per student)
- Notebook paper, loose (one per student)

Activity Preparation:

1. Fill plastic tubs approximately ¾ full of water. Add a few drops of food coloring to the water so students will be able to better see the movement of the water.
2. Set up hot plate for *Gear Up* demonstration.
3. Fill a pie pan about ½ full of water and place near the hot plate.

Activity Procedure:

Please refer to the assessment task and scoring rubric located at the end of these instructions. Discuss the assessment descriptors with the class before teaching this lesson.

Gear Up

Process Skills: observing, inferring, and communicating

1. Ask students to think about what they know about air pressure then record their answers in their lab notebook. Ask students to volunteer answers. Assign a class scribe to record answers on the board.
2. Place approximately 5milliliters of water into an empty soda can (just enough to cover the bottom of the can). Place the can on the ring stand or hot plate and heat until it has reached a vigorous boil. Ask the students to record observations in their lab notebooks while waiting for the water to boil then volunteer their observations to the class.
3. Explain what you are going to do next and have students predict what they think will happen and record their answers in their notebook. After the water is boiling vigorously, in a single motion using the tongs, remove the soda can from the burner and invert it in pie pan that is about ½ full of water, submerging the opening (cold water is best, but any temperature works).
4. Have students record their observations in their lab notebook and describe what happened with the air pressure inside the can before inverting in the pie pan and after inverting in the pie pan.

Explore: Part I

Process Skills: predicting, observing, and describing

5. Divide students into groups of three or four and assign them to a water-filled tub. Give each group a beaker. Tell students to insert the beaker into the tub of water multiple times and in multiple ways—sometimes so that it traps air inside the beaker, sometimes with the beaker full of water. Tell students to move the beaker up and down vertically in the tub, especially when the beaker is full of water. Have students document their observations in their lab notebooks.

Generalize: Part I

Process Skills: inferring, describing, making generalizations, and communicating

6. As a class, discuss the following:
   a. What happened when the inverted beaker was inserted straight down into the water?
   b. Why didn't water enter into the beaker?
   c. What happened when the full inverted beaker was partially lifted out of the water?
   d. Why did the water stay in the beaker?
   e. What forces are acting on it?
   f. What happened when the full inverted beaker was lifted completely out of the water?
   g. Why did the water spill out this time?
   h. What forces are acting on it?

Explore: Part II

Process Skills: predicting, observing, and describing

7. Hand out straws. Have students repeat exploration again, but this time using the flexible straw to try to change either the water level or air level inside the beaker. Instruct students they cannot use their mouths in any way to transfer water into the beakers. (NOTE: if you see students "trapping" water in the straw and transferring it to the beakers, see if you can get them to find other ways to change the air or water level in the beaker that doesn't involve physically moving the water.) Again, have students make observations and describe what happened in their lab notebooks.

Teacher's Note: Eventually students should be observed capping the long end of the flexible straw with their thumb while inserting the short end of the flexible straw into the beaker (the long end needs to extend outside of the top of the water in the tub). When they remove their thumb, air will either enter into or out of the beaker, thus changing the air/water level.

Generalize: Part II

Process Skills: inferring, describing, making generalizations, and communicating

8. As a class, discuss the following:
   a. What happened inside the beaker when the straw was inserted into the inverted empty beaker?
   b. What happened at the end of the straw?
   c. What happened inside the beaker when the straw was inserted into the inverted full beaker?
   d. What happened at the end of the straw?
   e. How did these situations change when a thumb was used to cap the straw?
   f. How were the forces different?
   g. How does what was observed relate to air pressure in the atmosphere?
   h. How does what was observed relate to a high-pressure system in the atmosphere?
   i. How does what was observed relate to a low-pressure system in the atmosphere?
   j. Why does water stop rising?
   k. Why does water stop falling?

Apply

Process Skills: inferring, describing, and making generalizations

9. Ask students to address the following scenario on a blank piece of paper that will be turned in: Explain why a car door cannot be opened when the car is in an accident and ends up submerged in a lake or river. What could be done to open the door if you were trapped inside this car?

Extension Idea: The answers to the apply questions could lead to a new explore and generalize session using a vacuum pump and bell jar. Running the pump a very short time creates a pressure difference great enough that it is impossible to remove the bell jar. This can also be explored using Magdeburg spheres if a vacuum pump is unavailable.

Source:

(2009). June 25, 2009. from http://dictionary.factmonster.com/

UNDER PRESSURE

RUBRIC

Assessment Task:

Using an 11" x16" piece of paper, students should create a diagram that predicts and describes what would happen to a balloon that is filled and tied shut at sea level and transported to the top of Mt. Denali in Alaska or another very tall mountain. The diagram must use captions and/or labels to describe how changing air pressure affects the balloon as it increases in altitude. Students should use arrows to indicate the forces acting on the balloon. The diagram must include at least one prediction about the affect cold temperatures will have on the air pressure in the balloon. Students may color-code the diagram.

Students may also create another diagram (on the same poster) that predicts and describes what would happen to a balloon that is inflated and tied shut at the top of Mt. Denali in Alaska or another very tall mountain and brought back down to sea level. Colors may also be used in this diagram.

Rubric:

Objective	GLE	Below Proficient	Proficient	Above Proficient
The student describes how changing pressure causes air to expand or contract.	[7] SD3.1	The student does not attempt; describes an unrelated topic; states that decreasing pressure causes air to contract or states that increasing pressure causes air to expand.	The student describes how decreasing pressure causes air to expand or describes how increasing pressure causes air to contract.	The student describes how decreasing pressure causes air to expand and describes how increasing pressure causes air to contract.
The student makes predictions about the effects of temperature on air pressure.	[7] SA1.1	The student does not attempt; makes a prediction about an unrelated topic.	The student makes one prediction about the affect that cold temperature will have on a balloon as it is moved towards the top of a very tall mountain.	The student makes two or more predictions about the affect that cold temperature will have on a balloon as it is moved towards the top of a very tall mountain.
The student diagrams the forces of air pressure acting on an object.	[7] W3.2.4	The student does not attempt; creates a diagram without labels or captions; creates a diagram on an unrelated topic.	The student creates a diagram about air pressure with either captions or labels.	The student creates a diagram with captions and labels. Diagram is color-coded.