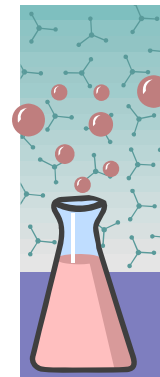


Suck It In! Not



Lesson Overview

After water is heated in a flask, a balloon is attached and the flask is cooled quickly. The balloon collapses into the flask demonstrating atmospheric pressure.

Suggested Grade Levels: 3~6

Standards for Lesson

Content Standard A: Science as Inquiry

Content Standard D: Earth and Space Science

VA SOL:

3.1 a, c, g, j; 4.1 a, b, c, f, g; 4.6 a, b; 5.1 e, f, g; 5.4 a, c;
6.1 e, f, g, h, i; 6.3 b, c, d, e; 6.6 a, b, e; LS.1 a, b, f, g, i;
PS.1 a, g, h, i, k, l, m; PS.2 a, c; PS.5 a; PS.6 a, c; PS.7 b, c

Time Needed

This lesson takes several class periods. Sample schedule:

- | | |
|------------|---|
| Day One: | Complete the Engage portion of the lesson |
| Day Two: | Complete the Explore and Explain portion of lesson |
| Day Three: | Complete the Elaborate and Evaluate portion of the lesson |

Materials for Lesson

- Small marshmallows
- Pressuring Pump
- Plastic soda bottle - 16 ounce size
- Erlenmeyer flask – 250 ml
- Hot plate or burner
- Latex balloons, 11 inch
- 25 ml water

- Ice bath or cold running water

Content Background

Information for teacher:

Air pressure is the force exerted on a given point by the mass of air molecules. Air molecules are invisible, but they still have mass and take up space (volume). Since there is a lot of empty space between air molecules, air can be pushed together, or compressed. When air is compressed, the molecules move closer together and air pressure increases.

Atmospheric pressure is the force exerted by the concentration of gases at a given point in the Earth's atmosphere. The *pressure* of a gas is related to the mass of gas molecules per unit of volume — i.e., *density*. Low pressure areas have less concentration of gases above their location while high pressure areas have a greater concentration of gases. As the density increases (more molecules closer together), so does the pressure that the gas molecules exert on their surroundings.

The density and pressure of atmospheric gases are related to their temperature. Both high-pressure and low-pressure systems start with the sun. Heat warms air molecules causing them to move faster and occupy more space. As they do, the concentration of gas becomes less dense. The warm air then rises, leaving an area of low pressure. As temperatures cool, gas molecules move closer together and pressure increases. Because the cooler air higher in the atmosphere is denser, it then sinks, replacing the air that has risen and creating an area of high pressure. When this dense air sinks toward Earth, it is eventually warmed, and the cycle continues. The replacement of the warmer (less dense) air by cooler (more dense) air is called convection *current*.

Air pressure is used to predict weather. When a high pressure system moves in, cooler temperatures and clear skies are expected due to the higher concentration of air molecules. There is less space for clouds and precipitation. If a low pressure system arrives, one can expect warmer temperatures that may be accompanied by gentle rain or severe storms. As the warm air rises, it cools and condenses to form clouds and precipitation.

Earth's atmosphere is pushing against each square inch of our bodies with a force of 14.7 pounds per square inch, or 1 kilogram per square centimeter, at sea level. That's approximately the weight of two gallons of water resting on one square inch. With this much pressure, why aren't we crushed? The air pressure inside our bodies balances out to equal the pressure outside our bodies.

In this demonstration, a difference in pressure is created by the collection of steam inside the flask covered by a balloon. As the steam cools, it condenses (molecules move together) and forms a partial vacuum inside the closed system. The pressure outside the balloon covered flask is at atmospheric pressure which at this point is greater than the pressure inside the flask. This

pressure differential causes the balloon to be pushed into the flask. The lower pressure inside the flask does not “suck” the balloon in. Rather, the higher pressure outside pushes the balloon into the flask. Eventually, the pressure inside the flask will equal the outside atmospheric pressure.

Engage

Activate students’ background knowledge, and engage them in the learning task by posing the questions: “What is a meteorologist? (*A scientist who studies weather*) “Where do meteorologists get information to develop a weather report?” (*From instruments that measure temperature, air pressure, winds, humidity, and precipitation*) Record student answers.

Ask students if they’ve ever heard anyone say, “I’m under so much pressure.” What might a person mean by this? Have students discuss with their shoulder partners. Allow students to share their ideas.

Tell the students that today we will explore what it means to be under pressure in terms of atmospheric pressure.

MARSHMALLOW MASHER:

Fill the 16 ounce bottle about half full with small marshmallows and screw on the special pressurizing pump.

Begin pumping to increase the pressure within the bottle. As you increase the pressure inside the bottle, students should make observations. They should notice how the marshmallows seem to become wrinkled and shrink. Do not pump more than 40 times! Have student record their observation and draw a picture of what happened to the marshmallows in their science notebooks.

When students finish, release the pressure by unscrewing the cap, but tell students to keep watching the marshmallows as they rapidly decompress. Have student record their observation and draw a picture of what happened to the marshmallows in their science notebooks.

COMPRESSED AIR:

Demonstrate how air can be compressed by using a syringe. Pull the plunger out as far as it will go without exiting the tube.

THINK-PAIR-SHARE: Ask students if there is anything inside the syringe. Have students draw a picture of the syringe and the air molecules inside the syringe in their science notebooks. Tell them to think about what happened to the marshmallows.

After sharing, place your finger over the end of the syringe and push in the plunger as far as it will go. Ask students what happened to the air inside the syringe. Have them draw a picture of the air molecules now.

After sharing, remove your finger from the end of the syringe. The plunger should push out. Ask student what happened and what caused the plunger to push out. Ask students what happened to the air inside the syringe. Have them draw a picture of the air molecules now.

Explore

Note: Teachers should practice this activity before presenting it to students. Remind students of safety precautions related to hot glass and steam. Goggles should be worn.

Add approximately 25 ml of water into a 250 ml Erlenmeyer flask. Heat the water using a heat source. (You may want to start heating the water prior to student arrival.)

As the water comes to a boil and steam rises out of the flask, remove the flask from the heat source. Quickly slip the balloon over the mouth of the flask. (Tips: Make sure that the balloon has been stretched and inflated/deflated several times prior to this demonstration. The balloon needs to be centered on the opening.)

Place the flask into a bath of ice water (cool water will work also). Tell students to make observations.

The balloon should be pushed in until it fills the entire flask. (Tip: As the balloon begins to collapse, push it slightly into the flask so that it doesn't collapse onto itself.)

Explain

Go back to the students' observations and drawings. Have students share their observations beginning each sentence with "I saw...", "I heard...", etc. **SINGLE ROUND ROBIN**

Distribute index cards. Have students think or write question about their observations. Ask them: What do you still wonder about what happened? These will be collected as the exit ticket. Ask students if they have any ideas why the balloon collapsed inside the flask. Tell them to think about what they learned about air pressure and what the molecules were doing in previous lessons. Ask students to share their ideas with shoulder partner **RALLY ROBIN**

While students are discussing, quietly assess student responses and select 5-6 students (SAGES) who seem to grasp the scientific principle.

CIRCLE THE SAGE: Have the SAGES spread out around the room. Tell remaining students to gather around the SAGE with no two members of the same team going to the same sage.

Have the sages explain why the balloon collapsed into the flask. Students return to their seats and discuss what the sages said. If there is disagreement, the team stands. Discuss with whole class to clarify any misconceptions.

Collect the index cards as an exit ticket. Tell students that you will do something with their questions during the next science class.

Elaborate

Using the questions from the previous day's lesson, design an experiment using a modified "4-Question" strategy. Most likely one of the students' questions will be, "Why did the balloon collapse into the flask of water?" Use the materials embedded in the question (underlined) as the materials for the next experiment.

On the "Under Pressure" Experimental Design sheet, tell students that the first question listed was one of the questions on an index card. Ask students to underline the materials that are in the question and to compare

THINK-PAIR-SHARE: For the next question, have students **THINK** about question one and record responses. After one minute, have students pair with their shoulder partner and **RALLY ROBIN** to compare and add answers. Then allow students share answers with the class. Some ideas that students might generate based on changing the materials include:

Different color/size/type balloons
Different size/shape flasks
Different amount/type/temperature liquid

As a class, select one independent variable from the list of student generated answers. Place this variable into the next question. Then ask students to think of ideas for the last question to describe or measure the affect on how the balloon collapses. Select one answer as the dependent variable.

Note: Due to safety issues, younger students should not do this experiment in teams. Older students may do the experiment. In either case, safety rules and procedures need to be discussed.

Before doing the experiment as a class, model for students how to construct a data table using the independent and dependent variables as heading for the rows and columns, respectively. Have them copy the data table in their science notebooks.

Evaluate

Use the following questions and student responses as a basis for class discussion:

- What happens to the air in the flask when the water was heated? (*The air in the bottle was heated by the hot water. As the molecules got hot, they moved farther away from each other. Therefore, the air expanded.*)
- How do you know that is what happened? (*Because the balloon began to inflate*)
- As the flask cooled, what happened to the air in the flask? What happened to the balloon as a result of this? (*The air in the flask cooled and the molecules moved closer together thus reducing the pressure. As a result of this, the pressure was greater outside of the flask and pushed them balloon in.*)
- How are low-pressure systems formed? (*When the air near the surface of the Earth is heated, the air molecules spread out so there are fewer air molecules in the same space. Warm air weighs less than cool air, which means that warm air presses down on Earth less than cool air does. A mass of warming air is an area of low pressure.*)
- How are high-pressure systems formed? (*When air cools, the air molecules come closer together, so there are more air molecules in the same space. The air mass becomes heavier and sinks toward the Earth, creating an area of high pressure.*)

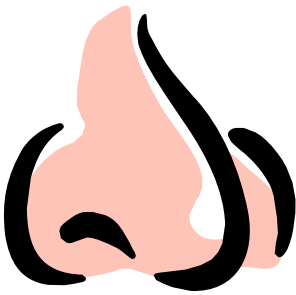
Sample assessment

- Have students describe in their own words how atmospheric pressure affects the weather.

Observation Sheet



What do you see with your eyes?



What do you smell with your nose?



What do you hear with your ears?

Under Pressure Experimental Design Sheet

Why did the balloon collapse into the flask of water?

What could you change about each material to affect how balloon collapses?

If you change _____, what could you describe or measure to determine if _____ affects how the balloon collapses?

Under Pressure Lab Sheet

My independent variable is _____
_____.

My dependent variable is _____
_____.

My question is:
What is the effect of _____ on
_____.

My hypothesis is:

_____.

Independent Variable:	Dependent Variable:			

List levels	Trial 1	Trial 2	Trial 3	Average

3. Safety Sheet

The following safety rules are to apply to this activity:

1. Roll up long sleeves and tie back long hair.
2. Wear safety goggles over your eyes.
3. When you heat anything in a flask or test tube, point the open end away from yourself and others.
4. Keep your work area clean and clear of materials that might catch on fire.
5. Use hot pad when handling hot glass.
6. Rapid changes in temperature may crack glass. Carefully check the flask before conducting repeated trials.