Discovering Earth's Air Pressure

Summary

This activity will help students understand the existence of air pressure on earth.

Materials

The Case of the Leaky Bottle

- Water
- 2-liter bottle
- Masking tape
- Empty tote tray

Pushing Air to the Limit

- Water
- Large V-8 can
- Tote tray
- Nail and hammer
- 12" balloon
- Scissors
- Masking tape

Additional Resources

Books

- *Weather*
  , Gail Gibbons 082340952X
- *Weather Words*
  , Seymour Simon, 0060884398
- *Handy Weather Answer Book*
  , by Walter A. Lyons 0760757674

Videos

- *Heat, Wind and Pressure*
  , VH, 2001 United Learning
- *Weather*
  , VH, 2001 United Learning

Background for Teachers

The air at sea level is about 15 pounds of air pressure per square inch. The higher we go above sea level on Earth's surface, like on a high mountain in Utah, the weaker the air pressure is, resulting in an air pressure that is below 15 pounds per square inch. As you can probably figure out, as air gets higher and higher above Earth's surface, it is less dense. There are fewer gas molecules in a given volume as we go up in elevation, therefore, making the air pressure less and less. Finally, at the edge of the air and space there is no hardly any air pressure at all.

Our atmosphere goes up about 70 miles above Earth. From 70 miles above Earth to the surface of Earth there are air molecules that occupy volume in the air. These air molecules create more and more weight on the air molecules under each one, pushing them closer together causing a significant amount of air pressure at Earth's surface. Think of five people stacked on top of each other, each weighing 100 pounds. The top person wouldn't feel any weight at all because nothing is on top of him, so he feels no pressure. The 2nd person from the top feels the weight of the one person, feeling 100 pounds of pressure. The third person from the top feels the weight of two people, feeling 200 pounds of pressure. The fourth person would feel 300 pounds of pressure. Finally, the bottom person would

feel 400 pounds of pressure as a result of four people being on top of him.
The air molecules stacked on top of each other react the same way. The air molecules at the top of the atmosphere (70 miles up) do not have much weight on them, resulting in very little air pressure. The air molecules at Earth's surface (the bottom of the pile) are being pushed together by all the weight of the air molecules from top to bottom resulting in 15 pounds of pressure per square inch.

Intended Learning Outcomes

1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles

Instructional Procedures

Invitation to Learn

The Case of the Leaky Bottle

Put four pinholes in a two-liter bottle vertically in straight line starting at the bottom and ending at the curve, equally distant from each other. Put masking tape over the holes. Put water in the bottle to the very top. With the bottle over a tote tray to catch the water, take the top piece of tape off.

Ask, "What do you see?" (Water is coming out of the hole.)

Ask, "What do you think will happen when the second tape is taken off?" (The water will come out of this hole too.)

Take the second tape off. Ask, "What are you observing now? (The water from the second hole is flowing out farther than the water from first hole.)

Tell them, "Predict what is going to happen when the third piece of tape is taken off." (They are probably catching on that water will shoot out of the third hole and go farther than the first and second streams of water.) Take off the third piece.

Ask, "What will happen when the fourth piece of tape is taken off the bottle?" (They will probably predict that the water will flow out farther than the other three.) Take off the fourth piece.

Ask the students, "Why is the water flowing out farther from the bottom hole than the other three holes?" (Have them give their answers of what they think.)

Continue to tell them that there is more weight at the bottom of the bottle than at the top of the bottle causing more pressure to push the water out stronger at the bottom than at the top. Tell them the example of the people stacked on each other from the "Background Knowledge" how the bottom person feels more weight and pressure than the other four on top.

Instructional Procedures

Pushing Air to the Limit

Tell the students that our air has about 15 pounds of pressure at Earth surface for the same reason the water had pressure to push the water out farther at the bottom of the bottle than at the top of the bottle. The difference is that there are air molecules stacked on each other causing the air pressure and not water molecules causing the air pressure. We are going to actually see the air pressure actively pressing against something today. (As you show this experiment have the students write down their predictions and what they observe in their journals.)

Get a large V-8 sized can and punch a hole in it with a hammer and nail.

Put a piece of masking tape over the hole.

Fill the can with water. Hold the can over an empty tote tray.

Ask the students, "What do you think will happen when I take the tape off the can?" (The water is going to flow out.) Take off the tape to see the water flow out.

Tell the students that they will be shown this experiment again, but this time before the tape is taken off we are going to stretch a balloon across the top of the can.

Dump the water out of the can. Wipe the water off over the hole where the tape was and put some more tape over the hole. Fill the can up with water. Dry off the lip of the can so the balloon

that you are going to stretch over the top won't slip off.
With scissors, cut off the neck of a 12" balloon. While someone is holding the can, stretch the balloon over the opening of the can.
Tell the students, "Predict what you think is going to happen now that there is a balloon on the can." (Have them tell their predictions.)
Tell the students to observe the balloon and the hole in the can closely. Take off the tape.
Ask, "What happened?" (The water ran out of the can for a little while but stopped running out. The balloon started to sink into the can and then stopped. As the balloon was actively sinking down into the can that is when the water was running out. As soon as the balloon stopped sinking down, the water stopped.)
Ask, "What pushed the balloon down into the can?" (Air pressure.) "What was the water doing with while the balloon was being pushed down?" (Water was coming out of the hole.) "Why did the water stop coming out?" (The air couldn't push the balloon down anymore and the water stopped coming out.)

Extensions

Curriculum Extensions/Adaptations/Integration

For advanced learners, have them investigate other ways of showing that air pressure exists.
For learners of special needs, have them replicate the experiments that they were shown and describe what is happening to a classmate.
Have the students draw a picture of what the air molecules look like bunched up together near the surface of Earth and how they gradually get further apart the higher the air molecules go out near the edge of space. (Visual Arts: Standard III, Objective 2)

Family Connections

Send home a list of materials needed for the students to show their families the two experiments they were shown or did in class. Have them explain the reasons behind the results of the two experiments.
Have the student go to the library and check out books about more experiments that can be done with air and pressure. Have them do them as families to learn more about the properties of air.

Assessment Plan

Divide the class into groups of three or four students and ask them to discuss and answer these questions in their journals or on paper. (See worksheet *What Is It With Air Pressure?*)

- What causes air pressure on Earth?
- Why isn't there as much air pressure higher in the sky as there is on Earth?
- Describe the experiment with the V-8 can and the balloon. Explain how this shows that air pressure exists.
- What do you think would happen if the balloon was taken off the top of the can?
- Would these experiments work up in the atmosphere? Explain your answer.
- How are the water in the bottle experiment and the water in the can similar?
- Thinking question: Why do you need air pressure to drink water from a straw?

Have the students draw a picture of the "air pressing on the balloon" experiment. Have them label the parts and show where the air pressure is with arrows. Have them write a caption of what is happening in the experiment.
Have the students replicate the experiment at their desks in groups of three or four. Then ask them to investigate further ways to show that air pressure exists with the materials they have.

Bibliography

Townsend, J., Bunton, K., (2006). Indicators for inquiry. *Science and Children*, Volume 43 (Number 5), Page 37

The National Science Education Standards specifically state that students should be able to observe simple objects and patterns and report their observations. When inquiry is involved with a hands-on approach, the topics cater to the natural curiosity of children and allow them to use a wide range of investigation and science-process skills. As children explore, the teacher can provide some guiding questions that may lead the way.

Heuser, D., (2005). Inquiry, science workshop style. *Science and Children*, Volume 43 (Number 2), Page 32

A good science workshop inquiry mode should be in three parts:

Exploration--hands-on experiences to produce interest and knowledge of desired science ideas to generate student questions.

Investigation--experiments based on student questions

Reflection--Reflective activities including discussion and writing to be unified in the results of the experiments. What did we learn?

Ketch, A., (2005). Conversation: the comprehension connection. The Reading Teacher, Vol. 59 (Number 1), Page 8

Students who engage in conversation in the classroom become reflective thinkers. Conversation brings meaning to life as they contemplate to understand our complex world. Conversation is the comprehension connection. There are literature circles, book clubs, whole-class discussions, pair/share, small-group discussion, and individual conferences.

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