Life of a Can

The Never-Ending Story

Classroom Activity

Novelis

Pressure's On!

Overview

In a quest to discover how air pressure is connected to implosions, students will watch their teacher implode a heated can by placing it in cold water. After observing this demonstration, students will work in groups to diagram a hypothesis of what occurred. A series of guided questions will then lead the class to a discussion of air pressure! Later, students will brainstorm situations and structures in which air pressure is especially important, and they will consider what engineers must consider when these structures are built.

Activity Duration: 2 class sessions (45-60 minutes each)
Grade Level: Grades 3–5

Background Information

Implosions and explosions are all related to pressure. During an implosion, pressure on the outside of an object is greater than pressure on the inside of the object, which causes the object to inwardly collapse. During an explosion, pressure on the inside of an object is greater than the pressure on the outside of an object, which causes the object to burst.[3]

When engineers construct transportation designed to move through different pressure zones, they must take this change into account. Consider the pressure that an airplane experiences. As altitude increases, air thins out. To keep humans conscious and healthy, airplane engines pressurize the internal air so it remains as similar to air pressure at sea level as possible. Plane engineers must therefore know that the plane alternates between pressure levels and is often at an altitude where its inside pressure is much greater than the pressure outside.[1]

Conversely, submarines exist in an opposite environment. In a submarine, the water pressure outside is stronger than the air pressure inside. Similar to airplanes, submarines pressurize their internal air so humans can survive. The walls of the submarine must also be strong enough to withstand this pressure and prevent the submarine from imploding.[3]

Key Vocabulary

Air Pressure: The force exerted by air molecules. The weight of these air molecules is always pushing down on us. As elevation increases, there are fewer air molecules. This means that air pressure decreases as altitude increases.[2]

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Materials

The teacher will need the following materials:

- Bucket filled with ice water
- 3 empty aluminum cans
- Hot plate/Bunsen burner
- Tongs
- Safety goggles

Each student will need the following materials:

- Demonstration Brainstorming Sheet (one per group of 3-4 students)
- Pressure Inquiry Sheet (one per student pairs)
- Exit ticket (one per student)

Procedure

Class Session 1

Prep (2 minutes)

1. Before the science period begins, prepare the following:
   a. Fill a bucket with ice water.
   b. Fill 3 empty aluminum cans with about ¼ inch of water each.
   c. Put on your safety goggles!

Demonstration (10 minutes)

At the beginning of class, capture students' attention with the following demonstration:

1. Place one aluminum can on the hot plate until the water begins to boil. (Be careful not to boil the water away!)
2. Use tongs to remove the aluminum can from the hot plate, quickly turn the can upside down and submerge the can opening into the bucket of ice water. (Note: The can will implode, and it will look like it has been crushed! Use the tongs to hold the can up to show the class.)
3. Once the class has seen the crushed can, explain that you are going to perform this demonstration one more time and a little more slowly. At the end of the demonstration, students will break into groups and discuss what they think just occurred.
4. Perform the demonstration again. This time, hold up the can at the beginning so everyone can see that it is a normal can. You may even want to allow the class to pass it around quickly. Explain that the can has a little bit of water in it and that as soon as the water begins to boil, you will be flipping it into ice water.

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Analysis (40 minutes)

1. Divide students into groups of three or four and explain that you would like each group to think about what just happened and why. Explain that after groups have a chance to discuss and write down their thoughts, the entire class will regroup about what happened.
2. Pass out a Demonstration Brainstorming Sheet to each group. Each group will be responsible for recording their thoughts on one sheet. Be sure to circulate the room during the small group discussions.
3. When student groups have wrapped up their discussions, bring the class back together and allow groups to share their thoughts.
4. Move the discussion towards air pressure by asking students to raise their hands if they have ever had their ears pop when they drove up a hill or took an airplane. Link ear popping back to the demonstration with the following explanation:
   a. Your ears popped because of air pressure! Even though it doesn't feel like it, air is pushing down on us all the time. Your ears popping is proof that the air pressure around you changed, and your ears are doing what they can to make the pressure the same outside and inside your eardrum!
   b. *(Note: For the rest of this explanation, perform the demonstration one more time so students are receiving your explanation and watching it occur.)* At the beginning of the aluminum can demonstration, the air pressure outside the can is the same as the pressure inside the can. As the water boils, water vapor begins to fill up the inside of the can and air is able to escape through the hole on the top. This helps the pressure on the inside and the outside of the can to remain similar.
   c. Submerging the can into cold water instantly lowers the air pressure on the inside of the can, because the cold water causes the water vapor in the can to condense (or turn back to water). Water takes up much less room than water vapor and has much less pressure than water vapor. Because the pressure on the inside of the can is so little and the air pressure on the outside of the can is so great, the can imploded.

Reflection (10 minutes)

1. Give students time to regroup once the class discussion is complete. Direct groups to review and revise the sketches on their brainstorming sheet to include a more accurate representation of what happened during the demonstration. This is also an opportunity to model the change in air pressure by drawing circles to represent air molecules and arrows representing air pressure.

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Class Session 2

Brainstorm (5 minutes)

1. Explain to students that engineers and scientists must always think about safety when creating anything that has the potential to implode or explode. Tell students that, while they recently saw an aluminum can implode, aluminum cans are also carefully constructed so that a can at risk of exploding will pop out its top and bottom first! This safety measure helps prevent the can from exploding into many different pieces.
2. Discuss that there are many structures made from aluminum and other metals that humans depend on *not* to implode or explode when pressure changes. Have students brainstorm a list of these items and keep track of the class's brainstorming on the board. Guide students towards including transportation on their list if they do not think of it themselves.
3. Ask: Why is it important to keep pressure in mind when it comes to transportation?

Inquiry (30 minutes)

1. Divide students into partners and have the pairs fill out the Pressure Inquiry Sheet.
2. Once student pairs are complete, match each pair up with another group and have them share their answers.

Share (10 minutes)

1. As the groups are discussing, assign each group a question (1 through 4) that they will be responsible for sharing with the class. As groups report on their answer, other groups should listen, add their own information, and ask questions.

Assess (10 minutes)

1. When student groups are complete, have each student individually fill out an exit ticket to demonstrate what they have learned.

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Demonstration Brainstorming

1. What does your group think happened during the aluminum can demonstration? Draw a picture in the boxes below. Be sure to label your drawing!

Aluminum can *before* it was heated	Aluminum can *while* it was heating	Aluminum can when it was put in cold water

2. Then use your group's drawings to help you answer:

   What changes did the can go through?

   _____
   _____
   _____
   _____

   Why do you think the can imploded? (Think about the changes it experienced!)

   _____
   _____
   _____
   _____

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Pressure Inquiry

1. Every day, people rely on transportation. Below, list of as many types of transportation as you can. (Remember to think about vehicles that fly high and swim low!)

   _____

   _____

   _____

2. Of the vehicles you brainstormed above, which two or three are the most likely to be impacted by air pressure? Why do you think this?

   _____

   _____

   _____

3. **Background**: Air pressure gets lower and lower as you go higher. Humans can't breathe when air pressure is too low. To keep humans safe and healthy, plane engines make sure that the air pressure inside an airplane is like the air that we breathe when we're standing on land.

   Think about it: If the air pressure inside an airplane is higher than outside the airplane, are planes more likely to implode or explode? How should engineers use this information as they design airplanes?

   _____

   _____

   _____

4. **Background**: Air pressure gets stronger and stronger as you go deeper underwater. To keep humans safe and healthy, submarines make sure that the air pressure inside a submarine is like the air that we breathe when we're standing on land.

   Think about it: If the air pressure inside a submarine is lower than outside the submarine, are submarines more likely to implode or explode? How should engineers use this information as they design submarines?

   _____

   _____

   _____

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Exit Ticket

Name: _____

When engineers are designing structures such as airplanes, submarines, and even rocket ships, why is it important to keep air pressure in mind? Include a drawing in your response to help prove your point.

_____
_____
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Exit Ticket

Name: _____

When engineers are designing structures such as airplanes, submarines, and even rocket ships, why is it important to keep air pressure in mind? Include a drawing in your response to help prove your point.

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Standards

Next Generation Science Standards

Performance Expectation 5-PS1-1

Develop a model to describe that matter is made of particles too small to be seen.

Disciplinary Core Idea 5-PS1-1

Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.

Works Cited

[1]Larsen, George. "How Things Work: Cabin Pressure." *Air & Space Magazine*. *https://www.airspacemag.com/flight-today/how-things-work-cabin-pressure-2870604/*

[2]NASA for Educators. "What is Atmospheric Pressure?" *https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/What_is_Atmospheric_Pressure.html*.

[3]UCSB Science Line. "How does something implode?" *http://scienceline.ucsb.edu/getkey.php?key=1844*.