Crushing Can

Kitchen Table Demonstration

The Rundown

Time: 5 minutes
Content: Atmospheric pressure
Safety Concerns: Minimal
Materials Availability: Common

Students will be amazed as an aluminum can is crushed by the force of atmospheric pressure. The demonstration allows observers to witness the influence of a pressure differential on an object.

Content Application

- Atmospheric Pressure
- Forces
- Gas Laws

Enduring Understandings

- Pressure is the force per unit area applied to an object in the direction perpendicular to its surface.
- Atmospheric pressure may vary, but it is generally measured to be around 14.7 psi at sea level.
- The pressure of a gas is directly proportional to its temperature if volume is constant.
- Forces on objects determine if and when they move.

Chemistry

Pressure is the force per unit area applied to an object in the direction perpendicular to its surface. It is often expressed in units of atmospheres (atm), pascals (Pa), millimeters of mercury (mm Hg), bars (bar), or pounds per square inch (psi). A gas excerpts pressure when its molecules forcefully collide with the walls of its container.

Atmospheric pressure is the force exerted over a surface area created by the weight of the air above it. At sea level, atmospheric pressure equals around 14.6 psi. This pressure decreases with altitude as the air becomes thinner with distance from the surface of the Earth.

The cylindrical form of an empty aluminum can is not solely the result of its structural design. Instead, it can be attributed more to a balance of pressure inside and outside of the can. When the top is opened, the force pushing out from gas molecules colliding with the inside of the can is equal to the atmospheric pressure pushing in the opposite direction.

When a small amount of water is heated in the bottom of an aluminum can, some of the water soon becomes vapor that expands to fill the entire volume of the can. If the can is quickly inverted in cool water, this vapor rapidly condenses back to liquid water that occupies significantly less volume and falls to combine with the water in the container. Air from the atmosphere is not able to rush in to fill the void left by the condensed vapor. This results in less air pressure within the can, causing the can to be crushed and some water from the container to be pushed up into the can.

Materials

- Aluminum can
- Hot plate or Bunsen burner
- Container holding cool water
- Heat resistant gloves or tongs

Safety

- Goggles
- Use caution when using heat source and locate applicable safety equipment (i.e. fire extinguisher, fire blanket, etc.)

Procedure

It's best to have several empty cans available to repeat the demonstration. If using a hot plate, start heating the water in the can(s) several minutes before the demonstration to save time.

Figure 1. Can is crushed by atmospheric pressure.

1. Fill an aluminum can with enough water to cover the bottom.
2. Heat the can on a hot plate or with a Bunsen burner.
3. Wait until the water boils and steam can be seen exiting the mouth hole. Wait for a few more seconds to allow the vapor to completely fill the can.
4. Using tongs or heat resistant gloves, quickly and carefully invert the can so that the top of the can is submerged in a container of cool water as shown in Figure 1. It is best to have the container of water immediately beside the heat source so that the transfer can be completed in one fluid motion.
5. The can will be crushed by the force of the atmospheric pressure. Water from the container will be pushed into the can by the atmospheric pressure.

Disposal

- Aluminum cans may be discarded in a normal trash receptacle or recycled if applicable.

Follow-Up and Student Participation

This demonstration can be done quickly by a teacher in front of the class. If more cans and time are available, it may also be completed by students in small lab groups.

This demonstration works well in conjunction with the "Egg in a Flask" and "Filling Flasks" demonstrations presented in this manual.

Try the following follow-up activities:

1. Using Think-Pair-Share, ask students to come up with explanations for the following:
   - Why aren't humans crushed by atmospheric pressure?
   - How do humans fill their lungs with air? "Suck" liquid through a straw?
   - Why do suction cups "stick" to a surface?

2. Predict-Observe-Explain (POE): What would happen if the same demonstration was repeated with no water in the can?

3. Present additional pressure-related demos using a bell jar and vacuum pump including:
   - Expanding a marshmallow
   - Expanding a rubber glove with warm air inside
   - Boiling water at room temperature