Expanding Peeps

Amount of time demo takes: 3-5 minutes

Try this in the classroom!

Lesson's Big Idea

- **Air pressure** is the force that is exerted on an object by air molecules. If physically possible, air molecules in a high pressure environment will move to a low pressure environment. Since Peeps have pockets of air contained in our high pressure atmosphere, putting a Peep in a vacuum will cause the Peep to expand in size.
- On any given item, there are 14.7 pounds per square inch of atmospheric pressure pressing on it at all times. When we use the air pump to remove the air from the canister, we are almost creating a vacuum, in which there is significantly less air pressure. Without the pressure, the Peep grows.

Materials

- Vacuum canister and pump
- A readily-expanding material to put within the canister. Suggestions: Peeps, marshmallows, shaving cream, balloons, or whipped cream
- Rags or Clorox wipes for clean up
- Magdeburg Hemispheres (2) (Optional)

SAFETY! Safe Demo!

Setup Instructions

- Set out the canister and supplies available to go inside of the canister

Background Information

- Gasses follow what is called the **Ideal Gas Law**. This law states that in a given system, $p\,V = n\,R\,T$:
  - p = pressure of the gas (Pascals, Pa)
  - V= volume of the gas (cubic meters, m^3)
  - n= the number of moles of gas (more loosely, how much gas there is)

    - R = 8.31 J/mol K, the universal gas constant
    - T = the temperature of the gas (Kelvin, K)
- When we use the pump to suck air out of the system, the value we are reducing is n, the amount of gas inside the chamber. The right-hand side of our equation is getting smaller. To keep the equation (and our system) balanced, the pressure, p, decreases inside the canister. Volume can't decrease (the container isn't shrinking) so to make up for the removed air, pressure decreases and our Peep expands!
- Upon pressing the button on the lid, air is let back into the container -- n increases, $R, T,$ and V once again stay largely unchanged, and p is left to increase. The Peep squashes back down to his original size under 14.7 psi.
- Magdeburg Hemispheres: When the hemispheres are pressed together air is forced out of the interior creating at least a partial vacuum. This seals together the hemispheres with a remarkable force. When air is removed from the interior of the hemispheres, there is no longer any force pushing outward and the atmospheric pressure outside dominates, pushing the hemispheres together and keeping them from being easily separated.

Instructional Procedure

1. Invite students to pick which item they'd like to expand.
2. After placing the item inside, put the lid on. Ensure that it is sealed tightly and completely!
3. Place the bottom of the pump over the gray seal in the middle of the lid. Being careful to keep the pump vertical, quickly pump out as much air as you can from the container.
4. Have the students continuously observe what is happening
5. At the end of the demo, press in on the button to let air back into the canister. Observe what happens to the expanded material.
6. Optional addition: Magdeburg Hemisphere
    a. Take the two hemispheres and push them together.
    b. Challenge a spectator to pull the hemispheres apart by grasping the handles and pulling straight outward.

Assessment Questions

- Why does the Peep expand?
    a. The vacuum creates an area of lower air pressure so the Peep is

able to expand without resistance

- Why do solid objects not expand so noticeably?
    a. A solid object's molecules are arranged in a tight pattern and have a strong attraction to each other so there is very little room for them to move. Liquids have attraction between molecules, but they are not arranged tightly allowing for more movement.
- What quantity did we change to reduce pressure inside the system?
    a. The moles of gas inside of the system
- How much air pressure is pushing on you all the time?
    a. 14.7 lbs per square inch

Careers & Real World Applications

- Construction - many construction workers have paste which is meant to expand over time once out of a sealed container.
- Engineers - when designing engines, it is vital to understand how the gas law works to ensure that the engine can process gas efficiently.
- Chemists - many chemical plants work with changing liquids to gasses so it is important to know how to predict how much the gas will change based on its environment.

Clean Up

- Thoroughly clean out the canister and lid to remove sugar, shaving foam, etc. Place the Magdeburg Hemispheres in a plastic bag to prevent them from drying out. Neatly package any materials that can be used for later demos.

References

- Arbor Scientific: http://www.arborsci.com/vacuum-pumper-and-chamber
- Physics for Scientists and Engineers by Randall D. Knight (p. 452-458)

Related Next Generation Science Standards

- K-5
    - 2-PS1 Matter and its Interactions
    - 5-PS1 Matter and Its Interactions
- 6-8
    - MS-PS1 Matter and Its Interactions
    - MS-ESS2 Earth's Systems