Egg in a Flask

Kitchen Table Demonstration

The Rundown

Time: 5 minutes-30 minutes
Content: Pressure, Gas Laws
Safety Concerns: Minimal
Materials Availability: Common

Atmospheric pressure is all around us. However, we hardly notice its force on our bodies. The following demonstration will allow students to "see" atmospheric pressure and appreciate the force it exerts upon objects.

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 pressure at sea level is almost the same as having a 15-pound dumbbell concentrated on every square inch of your body. Why don't you notice this force? How are objects able to exist without being crushed by this force?

The answer is that the atmospheric force is balanced by an opposing force. This will be illustrated in the demonstration. At the start, the atmospheric pressure is equal to the pressure inside of the flask. These equal forces acting in opposite directions allow the egg to remain at rest. After some heated gas in the flask is released and the remaining gas is cooled, the pressure inside of the flask is greatly reduced. The egg accelerates downward when the atmospheric pressure becomes greater than the reduced pressure inside of the flask. This egg is not "sucked" into the flask, it is pushed.

Materials

- 1000 mL flask
- ~6 hardboiled, pealed eggs
- Index cards ripped into long strips
- Lighter, matches, or burner

Safety

- Goggles – egg can blow apart in flask
- Flames – secure area and locate extinguisher (just in case)
- Force- the force of the egg being pushed in the bottle can cause the flask to slide or jump in place. If possible, place the flask on a soft surface, away from the edge of a table.

Procedure

Students always want to see this demonstration multiple times. It is important to repeat so that students are able to pick up on the subtle things that are happening. Also, eggs will break apart occasionally. For these reasons, it's best to prepare at least 6 hardboiled eggs. You must peal the shell off of each egg shortly before the demonstration.

Figure 1. Egg is pushed into flask

1. With a pealed hardboiled egg ready, light a strip of an index card ripped long ways.
2. Let the index card burn for a second or two, and drop it into the flask.
3. Immediately place the egg on top of the flask opening as pictured in Figure 1.
4. The egg may shutter as hot air rushes out of the top of the flask.
5. When the flame is extinguished, the pressure inside of the flask is reduced. With less air in the flask and less pressure, a pressure differential is created. The atmospheric pressure pushes the egg into the flask.

To remove the egg from the flask:

6. Invert the flask in the air.
7. Clear any pieces of paper from the opening of the flask.
8. Be sure that the opening of the flask is sealed by the egg.
9. Use your mouth to blow hot air back into the flask. The new pressure differential will cause the egg to be pushed back out. If you don't tell them, students will think you are "sucking" the egg out of the bottle.

Disposal

- All materials can be discarded in a normal trash receptacle. Be sure that it is emptied nightly, or you will be enjoying the smell of rotting eggs in your classroom.

Follow-Up and Student Participation

Although students could easily complete the demonstration in small groups, this requires much more time and preparation. The demonstration is most efficient when done by a teacher. It can be used in the beginning of a unit to increase student engagement or at the end of a unit as part of an assessment. It also works really well in the predict-observe-explain (POE) format.

This demonstration works well in conjunction with the "Crushing Can" 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. Students draw a diagram showing how atmospheric pressure changes with altitude.

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