Milk Bottle & Egg Demo

BOT-800

Egg in the Bottle

A hard-boiled egg placed on top of a milk bottle, is seen to vibrate and then quickly enter the bottle.

Fig. 1

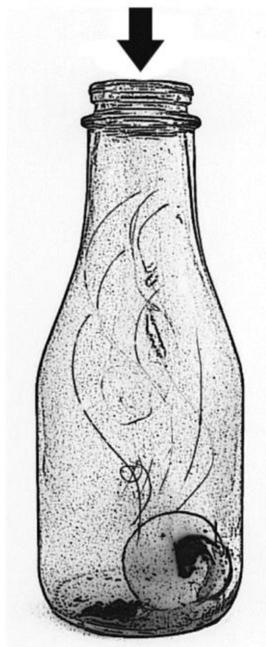

Fig. 2

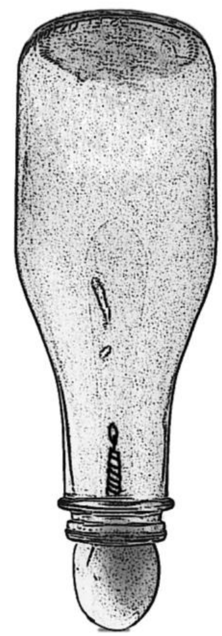

Fig. 3

Procedure:

1. Remove the shell of a hard-boiled egg, wet the egg with water, and then place the egg on top of an empty milk bottle. Note: it is important for students to see that the egg is larger than the opening of the milk bottle.

2. Ignite two or three matches, pick up the egg, drop in the flaming matches all at once, and quickly replace the egg on the top. Note: some prefer dropping in a flaming strip of paper (ca. 3 x 20 cm; 1 x 8 in, with a long crease to make it rigid).

3. When the flame extinguishes, the egg will enter the bottle with a pop.

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4. If the egg remains whole inside the bottle, you can remove the egg by inverting the bottle and blowing into it. Note: to avoid 'egg on the face,' before you stop blowing into the bottle, quickly move it to the side.

Alternate Procedure:

This method will remove the student's tendency to claim that gravity is potentially involved.

1. Prepare an egg as described in step 1 (above). Place on a suitable support (a soda bottle cap works well, but anything will do).
2. Insert a birthday candle into the top of the egg and ignite the candle.
3. Invert the bottle over the egg and burning candle so that the bottle touches the top surface of the egg.
4. As the candle extinguishes, air pressure should be sufficient to allow the bottle to be raised. The egg will remain in the opening of the bottle.
5. Hold the bottle steady. The egg will eventually be pushed upward into the bottle. Note: this version of the demonstration will take longer than the traditional method detailed above.

Special thanks to Jeff Feidler for introducing us to this interesting variation of a classic.

Discussion:

When air inside the bottle is heated, it expands and escapes around the edges of the egg. During this time, the egg is seen to vibrate. A wet egg helps form a nice seal on this 'one-way valve.'

When the flames inside the bottle become extinguished due to lack of oxygen, the gas inside the bottle cools. This cooling causes the pressure of the remaining gas inside the bottle to become less than outside atmospheric pressure. At that point, atmospheric pressure pushes the egg inside the bottle.

There is an alternative erroneous explanation that can be found in books and on the web. In fact, about half of the explanations on the web seem to use this explanation. The argument is made that the burning material removes the oxygen thus lowering the pressure inside the bottle. This ignores the fact that for each molecule of oxygen removed, a molecule of carbon dioxide or two molecules of carbon monoxide are formed.

The One Way Screen

Water can be poured into a bottle covered with a screen. When the bottle is inverted, the water doesn't come out.

Procedure:

1. Attach a double layer of nylon net screen to the top of a milk bottle with an elastic band.

2. Show students that water can easily be poured into the bottle through the screen.

3. Place a small piece of card stock (ca. 7 x 7 cm; 3 x 3 in.) on top of the screen, hold it in place with your hand, and invert the bottle over a sink or pan.

4. Slowly slide out the card.

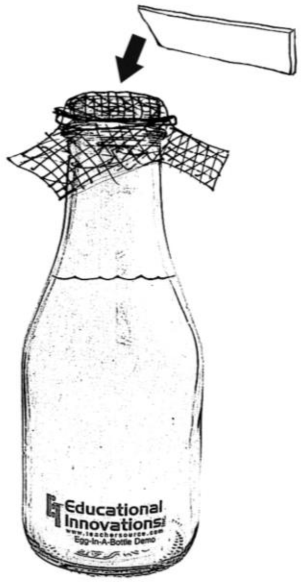

Fig. 4

Fig. 5

5. Ask students why the water does not flow out of the bottle. Why can you pour water into the bottle, but when inverted it does not flow out?

6. Tip the inverted bottle slightly and then bring back to the upside down position. What happens?

Discussion:

The force of flowing water allows the water to enter the bottle through the screen. Water in motion tends to remain in motion. When the bottle is inverted, the water stays in the bottle. The molecules of water have a greater attraction to themselves than to the screen. The water is said to exhibit surface tension.

In addition, when the bottle is inverted a small amount of water is lost from the bottle, the air which remains at the top of bottle slightly expands, and the pressure of the air inside the bottle is slightly less than the outside atmospheric pressure. The combination of the water surface tension and the greater outside atmospheric pressure explains why the water tends to remain in the bottle.

When the bottle is tipped slightly and then returned to the upright position, outside air enters the bottle and water runs out until the forces return to static equilibrium.

NGSS Correlations

Our Milk Bottle Demo and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

K-ESS2-1
Students can use and share observations of local weather conditions to describe patterns over time. Students can apply knowledge gained from the demonstration to understand the power of air pressure and its effects on weather.

K-ESS3-2
Students can ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. Students can apply knowledge gained from the demonstration to understand the power of air pressure and how air pressure is a factor in forecasting weather.

3-ESS2-1
Students can represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. Students can apply knowledge gained from the demonstration to understand the power of air pressure and its effects on weather/seasons.

3-PS2-1
Students can use the Milk Bottle in a plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

5-ESS2-1
Students can develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. Students can apply knowledge gained from the demonstration to understand the power of air pressure and how it interacts on Earth.

Middle School

MS-PS2-2
Students can use the Milk Bottle to plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-ESS2-6
Students can use the Milk Bottle to develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determines regional climates.

High School

HS-ESS2-4
Students can apply knowledge gained from the Milk Bottle demonstration to use a model to describe how variations in the flow of energy into and out of Earth systems results in changes in climate.

HS-ESS2-5
Students can use the Milk Bottle to plan and conduct an investigation on the properties of water as follows:

The Milk Bottle can be used in an investigation to explore water surface tension and static equilibrium. Place a piece of netting fabric over the mouth of the milk bottle. Secure it with a rubber band. Pour water into the milk bottle. Quickly invert the bottle. The water will not pour out.

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons.
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TeacherSource.com/lessons

Check our blog for classroom-tested teaching plans on dozens of topics:

http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

Magdeburg Vacuum Plates with Pump (VAC-200)

When a simple hand pump is used to evacuate the Magdeburg plates, about 140 pounds of force are needed to separate them. Place a folded dollar bill inside and offer it to any student who can pull apart the plates. A Super, Wow, Neat™ way to demonstrate atmospheric pressure! Students can measure the area of the rings and predict the force needed to separate the plates based on the atmospheric pressure.

Lil' Suctioner (SC-100)

This device is so simple, it's mind boggling. Simply slide the soft foam ring over a soda can or beaker and it sticks tight—really tight—to any smooth tabletop surface. Inadvertently invented by Mike Adjeleian, our 'suctioners' use air pressure to hold in place all sorts of circular containers (up to 3 inch diameter). Great for the lab, your desk or even at home.

Pressure Pullers (SC-300)

What keeps these cups together? Suction or air pressure? These cups are very simple to use: no vacuum pump—just two levers, yet they are incredibly difficult to pull apart. A great way to illustrate the concept that air pressure, not suction, is forcing the cups together. Have your students calculate, based on the area of the cup and the standard air pressure, just how much force is required to pull the cups apart.

Microscale Vacuum Apparatus (VAC-10)

Students can now safely produce a vacuum in a small bell jar right at their lab stations. By reducing the pressure in the microscale bell jar, they can expand a balloon, boil warm water, and even transfer liquids from one pipet to another. They can watch a marshmallow or shaving cream increase in volume as the pressure is reduced and learn about how extremely low pressure affects the world around them. Instead of passively observing a demonstration, students can actively experiment on their own and observe the results right before their eyes.