Pressure Pullers

SC-300

An apologetic note:

You will note that these instructions make references to 'suction,' 'suction cups,' and other related terms. While these terms are commonly used, we recognize that in science there truly is no suction. The pulling force of 'suction' is an illusion, caused by the pushing force of an unbalanced pressure. We recognize the difference, but for ease of understanding we chose to use these common terms. Besides, 'Pushed-Together-Because-They-Have-a-Lower-Pressure-than-the-Air-Around-Them Cups' doesn't have the same ring to it. Please don't write us angry letters...

Instructions:

This kit contains two Pressure Pullers with handles. Note that on each cup, one of the handles is in a fixed position, while the other is articulated and can be moved back and forth. When the two handles are 90° apart, the cup face is in the relaxed state; when the handles are parallel, the cup face is in the tensioned or 'sucking' state.

Move the handles on both Pressure Pullers into the relaxed position and press the two cup faces together. Carefully center them on each other, making the edges flush. Move the articulated handles so that each is in the parallel 'sucking' position. The two cup faces should now be holding firmly together.

For optimum performance:

- The contacting rubber faces must be clean—they do not need to be wetted
- The outer cup edges must be accurately aligned before squeezing the handles
- Squeeze both handles simultaneously
- You will notice that in the center of each cup there is a raised bump. If the bumps sit high enough, they may block the edges of the two cup faces from coming together. If this is the case, simply squeeze the handles together slightly to pull the bumps out of the way.

Using the Pressure Pullers

Important

These Pressure Pullers are designed to withstand forces pulling straight away from the handles. Do not apply any bending or twisting forces on the handles.

Also, design your experiments safely should the seal fail. Ensure that students are clear and objects being lifted by the Pressure Pullers are protected should the lifted object fall to the floor. Ensure that students pulling on the Pressure Pullers are not using excessive force, and that they will not fall and injure themselves or others should the Pressure Pullers come apart. You may wish to have 'back-up' students behind those students doing the pulling.

A great illustration of 'suction' vs. 'pressure'

By placing the two cup faces together and squeezing their handles, you are simply reducing the air pressure in the space between the two cups. The result? A higher air pressure on the outside surfaces of the Pressure Pullers.

It's the higher pressure of the outside air that forces them together—not a pulling force (commonly referred to as suction). You may wish to note that the Pressure Pullers decrease pressure ***not*** by removing air, but rather by increasing the volume of the space the air occupies.

Two students will have difficulty pulling the cups apart. A significant force is required to separate the cups. As noted above, be aware that students should not exert a large enough force so that when the cups separate, the pulling students can quickly fly backwards.

Before actually performing a demonstration, a good class exercise is to have the students determine the PRESSURES forcing the cups together. Have them do an approximate calculation using:

- A cup's diameter—calculate the area of the surface of the cup
- A pressure differential of 10 lbs/sq in
- The relationship: **PRESSURE = FORCE / AREA**

It is amazing that such an apparently small reduction of air density can provide such forces. It is also amazing to actually experience the forces involved with pressure differences.

NGSS Correlations

Our Pressure Pullers 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 Pressure Pullers 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 Pressure Pullers 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 Pressure Pullers 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 Pressure Pullers 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.

Suggested Science Idea(s)

K-ESS2-1 • K-ESS3-2 • 2-PS1-2 • 3-ESS2-1 • 3-PS2-1 • 5-ESS2-1 • MS-PS2-2 • MS-ESS2-6 • HS-ESS2-4

The Pressure Pullers will help students to feel the power of air pressure. Use it to teach students the truth about air pressure: There is no suction! Students can calculate based on the area of the cup and the standard air pressure to calculate how much force is required to pull the cups apart.

Common Units of Force and Pressure

1 atmosphere = 760 millimeters of mercury (Hg)
= 1.013 x 105 pascals
= 14.70 pounds per square inch
1 torr = 1 millimeter of mercury (Hg)

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons.
For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

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.

Milk Bottle & Egg Demo (BOT-800)

Use this sturdy glass milk bottle for an egg-cellent demonstration of air pressure. All you need is a hardboiled egg and a little bit of fire. If you drop some lit paper inside the milk bottle and then place the egg on top, the fire goes out and the egg is mysteriously pushed into the bottle, intact! Warm air expands, cool air contracts—it's the cooling of the heated air inside the bottle that allows the atmosphere to 'push' the egg inside.

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.