Pressure Globe

P1-2015

INSTRUCTIONAL GUIDE

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- Stopper
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Recommended for activities:

- Water

Background

Gases consist of particles in a random motion. Due to this motion, gases exert pressure. Pressure is defined as the force exerted by the particles on a unit area of surface. The SI unit of pressure, the Pascal, equals one Newton per square meter.

The pressure of a gas depends on a number of factors. These include temperature, the volume of the container confining the gas, and the number of particles of gas. Higher temperatures correspond to faster moving particles. Faster particles have more momentum and make more frequent collisions with the walls of the container. Both factors lead to increased pressure. Increasing the volume of the gas reduces the number of collisions per unit time between the particles and the container walls and hence reduces the pressure.

Robert Boyle is credited with discovering the quantitative relationship between the pressure and the volume of a gas at constant temperature. He found that the pressure and volume are inversely related. Boyle's Law states that the product of the pressure and volume is constant, provided the temperature does not change. Later, Jacques Charles found that if the pressure is held constant, the volume of a gas varies directly with the temperature.

These two basic principles are included into a single statement known as the Ideal Gas Law. This law, which also expresses the fact that both the pressure and volume vary directly with the number of gas particles, may be stated as PV = cT, where P is the pressure, V the volume, c is a constant which depends on the amount of gas, and T is the absolute temperature.

One of the common misunderstandings regarding the behavior of gases is the notion that suction is a force. While it may appear that suction is responsible for the inward motion of your cheeks when you remove air from your mouth, the actual cause of the collapse is a difference in pressure. By removing air from your mouth, you reduce the internal pressure. The greater external pressure exerted by the atmosphere pushes your cheeks inward.

Similarly, if a "suction" cup found on a toy dart or bathroom plunger is pressed against a smooth surface, air inside the cup is expelled. The reduction in gas particles in the enclosed volume results in reduced pressure inside the cup. The greater external pressure pushes harder against the rubber cup than the internal pressure pushes out and the plunger sticks to the surface.

The Pressure Globe, is an excellent device for illustrating the effects of air pressure. After witnessing the demonstrations described below, students should be able to construct a more accurate understanding of phenomena associated with the pressure exerted by gases.

Instructions

1. Place a balloon into the lipped opening of the Pressure Globe. After stretching the mouth of the balloon over the lip, blow into the balloon until it conforms to the bottle's interior surface. Insert the stopper in the bottom hole while retaining the pressure inside the balloon. Once the stopper has been firmly inserted, remove your mouth from the balloon. What do you observe? Why does this occur? Listen carefully as you remove the stopper from the bottle. What do you hear? What is going on?

2. Place the balloon into the lipped opening of the Pressure Globe and place the stopper in the bottom hole. After stretching the balloon over the lip, blow into the balloon. Are you able to inflate the balloon? Explain your observations. Now remove the stopper and once again try to inflate the balloon. Describe what happens this time. Why are the two situations different?

3. Prepare the Pressure Globe following the procedure in **Step 1**. Once the balloon has been fully inflated and the stopper placed in the bottom hole, pour approximately 100 ml of water into the balloon. With the large opening facing upward, place the Pressure Globe over a sink. Now remove the stopper. What happens? What force causes the water to squirt out of the bottle?

Related Products

Pressure Pumper Kit (P1-2060) Kit includes 15 Pressure Pumpers, 15 Temperature Strips, and three activity sheets. Bottle not included.

Gas Laws and Pressure Discovery Bundle (P1-2070) Don't just teach the gas laws. Let students deduce them with these exploratory activities!

Advanced Gas Laws Demo (P1-2065) Quantitatively confirm the Combined Gas Law with one complete apparatus! Students can verify this relationship using air and this unique apparatus.

Atmospheric Mat (P1-2010) A simple design that demonstrates a powerful concept: atmospheric pressure! Place this rubber mat on any flat surface and pull on the handle. It's like the mat is glued down!