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Harbottle Pressure Globe
#791

Warning:

- **Not a toy; use only in a laboratory or educational setting.**
- **Contains latex.**
- **Choking hazard - comes with a balloon.**

Introduction

The Harbottle Pressure Globe is a demonstration of the effects of air pressure. The demonstration is a fun and visual tool used to help students grasp the concepts associated with air pressure. The pressure of gas depends on a number of factors, including temperature, volume, and the number of particles in the gas.

The basic principles of gas can be stated as the Ideal Gas Law which is an approximation of the behavior of gasses. The Ideal Gas Law was first stated by Emile Clapeyron as a combination of Boyle's law, Charles's law and Avogadro's law. The Ideal Gas Law is a good approximation for most gases under moderate pressure and temperature. It goes as follows:

$$PV=nRT$$

- **P= Pressure (Pascals)**
- **V= Volume (meters^3)**
- **n= Molecular Quantity (moles)**
- **R= Constant (8.314 J/[K·mol])**
- **T= Temperature (Kelvins)**

This law has the following important consequences:

- If temperature and pressure are kept constant, then the volume of the gas is directly proportional to the number of molecules of gas.
- If the temperature and volume remain constant, then the pressure of the gas changes are directly proportional to the number of molecules of gas present.
- If the number of gas molecules and the temperature remain constant, then the pressure is inversely proportional to the volume.
- If the temperature changes and the number of gas molecules are kept constant, then either pressure or volume (or both) will change in direct proportion to the temperature.

How to Use

Demonstration 1

1. Place a balloon in the lipped opening of the globe.
2. Stretch the open end of the balloon over the lip of the globe.
3. Blow into the balloon until it fills the open space inside the globe.
4. Insert the stopper in the bottom of the globe. **(Note:** Be careful when inserting the stopper into the Harbottle. Gently place it in the opening only enough to stop airflow in the chamber.**)**
5. Remove your mouth from the balloon. Observe that the balloon remains inflated.
6. Discuss why.

   (The balloon remains inflated, even with the mouth of the balloon open because the pressure inside of the balloon is greater than the pressure outside of the balloon. The balloon pushed all of the air and air pressure out of the bottom of the bottle. At this point, the air pressure inside the balloon is greater than the air pressure outside of the balloon, so it stays inflated.)

Demonstration 2

1. Place the balloon into the lipped opening of the globe and place the stopper in the bottom of the globe.
2. Blow into the balloon. Does the balloon inflate?
3. Discuss why the situations in Demonstration 1 and 2 are different.

Demonstration 3 (Note: Best done over a sink!)

1. Prepare the pressure globe as you did in Demonstration 1.
2. Inflate the balloon and gently place the stopper in the bottom of the globe.
3. Pour approximately 100ml of water into the balloon.
4. With the large opening facing away from you and away from onlookers, remover the stopper.
5. Discuss what force causes the water to squirt from the globe and balloon.

Safety Precautions

- Before each use, **inspect the apparatus for any fractures in the glass** that can develop during shipping or through improper storage and rough use.
- **When inserting the stopper into the Harbottle,** especially when you are doing so with your lips pressed to the balloon like in Demonstration 1, **do so gently until airflow is stopped.** If more pressure must be applied to keep the seal in place, only do so cautiously and away from your face.
- **Wear thick gloves and impact goggles** for protection from any accidental breakage.