Gas Law

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**Objective**: The purpose of this lab is to measure the relationship between the volume, temperature, pressure and amount of gas that is help in a closed container. This will be accomplished by first measuring the relationship between the pressure and volume of a gas, next by measuring the relationship between pressure and the amount of gas occupying the container, and finally by observing the relationship between pressure and temperature. These collective observations will be used to derive The Ideal Gas Law.

**Procedure**

The experiment will be performed using a syringe, small rubber tubing, some valves, an electronic pressure sensor, an air canister, a temperature sensor, a heat source, and the Data Studio computer interface software (to collect the data from the pressure sensor and temperature probe). The gas to be used to fill the apparatus will be the surrounding air. The syringe, pressure sensor, air canister, and valves will all be connected together by the rubber tubing to make a system closed form the surrounding air.

First, the syringe will be used to draw in varying amounts of air (15cc – 60cc), and the pressure will be recorded. This will help demonstrate the relationship between pressure and the volume of the container. Then, the cylinder will be evacuated, wither manually or with a vacuum, until the cylinder can be considered void of air. Then the syringe will be used to fill the canister by injecting 60cc of air at a time, and then the pressure from inside the canister will be measured after each successive injection. This will demonstrate the relationship between the amount of gas in a container and the pressure. Finally, using the canister filled with only the gas injected into it in the previous step, the cylinder will be heated. Measurements will be collected at 10 degree C intervals. This will demonstrate the relationship between temperature and pressure.

**Theory**

“The Ideal Gas Law describes the relationship between pressure, volume, the number of atoms or molecules in a gas, and the temperature of a[n] [ideal] gas” (Lab Instructions, “The Ideal Gas Law”). An ideal gas is a theoretical concept, it is a gas whose constituent particles do not interact and occupy no space. While no real gas is an ideal gas, most gases do act very similarly, thus making them appropriate for the focus of our experiment.

When discussing gas law, it is centered about the idea that a gas is made up of particles that vibrate randomly due to their heat energy. This causes these particles to move about, sometimes traveling through empty space, sometimes colliding with one another or the walls of their container (if one is present). These collisions are the basis for the concepts of the experiment.

Pressure can be defined as force exerted per area, and the collisions of the particles against the wall of their container exert a force on the container wall. More collisions mean more forces exerted on the wall, and vice versa. Then it reasonably follows that when a larger amount of gas occupies the container (more particles), the magnitude of pressure will be larger; when the temperature of the gas (kinetic energy of the particles) is higher, the pressure will be higher due to more frequent and stronger wall collisions; but when the volume of the container is larger, the pressure will be lower because the gas particles have more empty space to travel through, thus making collisions less frequent.

Important to Physics, notably for the discussion of Gas Law, is the concept of proportionality, where the (proportional to) operator is often used to define the relationship between two variables. In the previous paragraph, the relationship between pressure and other variables was described in words. Those relationships can be defined in terms of proportionality in the following manner:

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The Ideal Gas Law itself is defined as:

Where:

P = Pressure exerted by the gas on its container, in Pascals (Pa)

V = Volume of the container, in cubic centimeters

n = is the Number of moles of particles (amount of gas)

R = Ideal Gas constant = 8.3145

T = Temperature of the gas, in Kelvin