Name: Period:

**Molar Volume of a Gas**

**Background**

Avogadro’s hypothesis states that equal volumes of all gases contain equal number of molecules under the same conditions of temperature and pressure. It follows from this hypothesis that all gas samples containing the same number of molecules will occupy the same volume under the same conditions of temperature and pressure. A special name is given to the volume occupied by 1mol samples of gases at STP. This volume is called the *molar volume*. In this experiment, you will make an experimental determination of the molar volume.

The basis of this experiment for the following reaction in which you will react a known mass of magnesium with excess hydrochloric acid to produce the substances shown:

Mg(s) + 2HCl(ag) → MgCl2(ag) + H2(g)

The hydrogen gas is the product that is of interest to you in this experiment. You will make an experimental determination of the number of moles of hydrogen molecules produced and the volume occupied by these molecules. The number of moles of hydrogen will be determined indirectly. The balanced equation for this reaction shows that the molar ratio of magnesium reacted to hydrogen gas produced is 1:1. Therefore, by determining the mass of magnesium that reacts and the number of moles that his mass is equal to, you will also determine the number of moles of hydrogen gas produced. The volume of hydrogen gas produced will be measured directly on the scale of a gas-measuring tube. The gas laws of Boyle and Charles will be used to correct this volume, *measured under laboratory conditions*, to the volume the sample of gas would occupy at STP. The collected data (number of voles and volume at STP) will be used to calculate the molar volume of the hydrogen gas.

**Procedure**

1. Obtain a piece of magnesium ribbon from your teacher. Measure the length of the piece of ribbon (±0.1cm). Record the length. Also record the mass of 1m of magnesium ribbon. This will be provided by your teacher.
2. Obtain a piece of cotton thread about 15cm long. Tie one end of the thread around the piece of magnesium ribbon, leaving about 10cm of thread free. Bend the piece of magnesium so that it will fit easily into the gas-measuring tube.
3. Obtain about 10mL of 3M HCl. Carefully pour the HCl into a gas-measuring tube.
4. Tilt the gas-measuring tube slightly. Using a beaker, slowly fill the gas-measuring tube with distilled water completely to the top. Try to avoid mixing the acid and water as much as possible.
5. Lower the piece of magnesium ribbon 4 or 5cm into the gas-measuring tube. Drape the thread over the edge of the tube and insert the one-holed stopper into the tube. There should be no air in the gas-measuring tube at this point.
6. Add about 200mL of distilled water to a 400mL beaker. Set up a ring stand and utility clamp, and place the beaker of water in the position shown.
7. Place your finger over the hole in the rubber stopper and invert the gas-measuring tube. Lower the stoppered end of the tube into the beaker of water. Clamp the tube in place so that the stoppered end is a few centimeters above the bottom of the beaker. Record your visual observations.
8. Let the apparatus stand about five minutes *after* the magnesium has completely reacted. Then, tap the sides of the gas-measuring tube to dislodge any gas bubbles that may have become attached to the sides of the tube. Place your finger over the hole in the stopper and transfer the tube to a 1000mL flask filled with water. Lower the end of the tube into the water and remove your finger from the hole. Make sure that no additional air is introduced into the tube.
9. Move the tube up or down (to equalized the pressure) until the water level in the tube is the same as that in the 1000mL beaker. Using the scale on the gas-measuring tube, read the volume of the gas in the tube. Record.
10. From your teacher, gather the room temperature as well as the barometric pressure.
11. Repeat the experiment for a second trial. When complete with the second trial, average all of the appropriate information in your data table.

**Lab Write-Up**

On your own sheet of paper, you will turn in your observations, data table, and calculations. Your task is to calculate, from your experimental data, the amount of L/mol of a gas at STP. We know the accepted value to be 22.4L/mol therefore you will also need to calculate your percent error. Hints to help:

* Some calculations will require the use of a proportion
* You will use the combined gas law at some point
* To calculate the pressure of hydrogen you need to take the barometric pressure and subtract the partial pressure of water (get this value from your teacher)