Name:_____ H Chem Period:____

Lab Partner(s):_____

Volume of Hydrogen Gas and the Ideal Gas Law

Introduction:

Gases cannot always be seen, but we can observe their behavior and study their properties. This lab will apply several concepts from Ideal Gas Laws. In this experiment magnesium reacts with hydrochloric acid in a single replacement reaction. You will use your knowledge of chemical reactions and gas phase stoichiometry to *predict* the theoretical number of moles of gas formed. You will then use the Ideal Gas Law to predict the theoretical volume of the gas formed. Then you will carry out the actual reaction, measure the actual volume of gas generated, and use Dalton's law of partial pressures to calculate the actual number of moles of gas produced which will be compared to the theoretical moles predicted.

Safety:

- The HCl solution is corrosive and irritating to the eyes and skin. If you spill it on yourself, rinse the affected area with cool water. *Wear gloves and goggles!*
- Be very careful with the gas collection tube and other glassware – no breakage!

Equipment and Materials:

- 400 mL beaker
- Balance
- Ring stand
- Buret clamp
- One-hole rubber stopper to fit gas collection tube
- Gas collection tube (50 mL)
- 2 M Hydrochloric Acid (HCl)
- Magnesium ribbon (~40 mg)
- Copper wire
- 10 mL graduated cylinder
- sandpaper

Equations to use for the calculations:

°C + 273.15 = K

PV = nRT

Dalton's Law of Partial Pressure: $P_{Gas} = P_{Total} - P_{H2Ovapor}$

$$\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

Procedure:

1. Obtain a 50 mL gas collection tube. Condition the tube by rinsing with water and distilled water.

2. Obtain a piece of magnesium from the materials bench and clean the surface of the magnesium by rubbing it with a small piece of sandpaper until the surface is shiny and free of dull or dark streaks. Only touch the Mg ribbon on the side and obtain the mass on a balance. Record the weight in data table 1 with all the numbers the balance provides.

3. Obtain a piece of copper wire from the equipment bench.

4. Prepare the Mg ribbon for reaction - after getting the mass, fold and crumple the magnesium and use the copper wire to wrap around it like a ball of yarn on string, so that the Mg remains compacted, but leave ~2" (~5 cm) of copper wire straight. Make sure the magnesium will not fall out if shaken.

5. Obtain ~ 10 mL of 2 M HCl with your graduated cylinder. Tilt your gas collection tube slightly and add the HCl.

6. With your tube slightly tilted and using your plastic (squeeze) bottle of distilled H_2O, **slowly** add distilled water by running it down the inside wall of your collection tube (this will minimize premixing of the HCl and water until the tube is inverted for gas collection). By this method, carefully layer about 15 mL of distilled water over the HCl, **avoid mixing**. Now you can increase the rate of addition of water and fill the collection tube completely to the top.

7. Form a small hook with the end of the straight portion of the copper wire with Mg ribbon. Then insert the Mg into the collection tube and **hook it** over the tube opening with the metal hook you made so that the copper wrapped Mg extends down ~2" from the narrow end of the stopper **[Be careful not to drop the assembly into the collection tube!]** Put the #00 one-hole rubber stopper in place over the opening of the collection tube. A water bead should form at the top of the one-hole rubber stopper. If not add more water with your squeeze bottle.

8. Add approximately 300 mL of water into your 400 mL beaker (water reservoir).

9. Holding your finger firmly over the hole in the rubber stopper **invert** the tube into the 400 mL beaker containing the 300 mL water. Release your finger when the collection tube is under the surface of the water in the beaker. Clamp the collection tube in the buret clamp, so that the end of the tube is ~2" under the surface of the water but not touching the bottom.

10. Allow the reaction to come to completion. There should be no more magnesium left when the reaction is complete. Record the volume of gas produced in the data table.

Lab: Volume of Gas and Ideal Gas Law

Data:

Data Table: Mass of Magnesium and Conditions of Reaction

Mass of magnesium	
Barometric Pressure	
Temperature of Water	
Volume of Gas from Collection Tube	

Write the balanced formula equation for this reaction.

Observations of reaction:

Conversion of Barometric Pressure to atmospheres:

Conversion of Temperature:

Theoretical moles of gas:

Theoretical Volume of Gas:

Actual Moles of Gas (adjusted using Dalton's Law of Partial Pressures): $P_{Total} = P_{gas} + P_{water}$

Water vapor pressure:

Percent Yield of moles of Gas:

Results:

Results Table: Hydrogen Gas Produced

Theoretical moles H_2 gas produced	
Theoretical volume H_2 gas produced	
Actual volume of H_2 gas produced (V_{Total})	
Actual moles of H_2 gas produced	

Percent Yield	

Post Laboratory Questions.

1. Why are we using copper wire to hold the magnesium? Explain and be specific why.

2. A 1.311 g sample of a certain metal reacts with hydrochloric acid to produce 380.0 mL of H_2 at 20.0 ˚C and 720.0 torr pressure.

    a. Write a balanced **net ionic** equation for the reaction, assuming that the metal forms an M^{2+} ion in solution.

    b. Determine the identity of the Metal.

3. Calculate the maximum mass of calcium metal that should be used in this experiment with a 50-mL gas collection tube. Assume that the H_2 gas generated occupies 45.0 mL at standard conditions.

4. The volume of gas produced was measured at room temperature and pressure. Using the data collected in this lab, calculate the molar volume of gas at STP.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Conclusion: *Start with a purpose statement***.** Summarize the results for evolution of gas and percent yield in this week's lab. *Be sure to include data*. Remember no procedure should be included in a conclusion and only write in 3rd person.