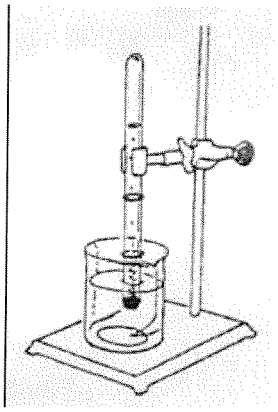
Name: _____ Block: ___ Date: _____

Gas Laws Lab



Purpose

In this experiment, you will produce hydrogen gas, H_2 ,by reacting magnesium with hydrochloric acid according to the following equation:

$$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$$

You will assume the hydrogen is an ideal gas, and you will measure its mass, volume, temperature, and pressure. From these measured values, you will calculate the molar volume of hydrogen and compare the result with the ideal value above.

Materials

Eudiometer (Buret)
Hydrochloric acid (6 M)
Magnesium ribbon
Copper wire
Thermometer

APPLICATION OF PRINCIPLES

1. Tell whether the following errors would **increase**, **decrease**, or have **no effect** on the experimental molar volume.

   a) the measured mass of the magnesium was too small

   b) the actual temperature of the hydrogen is less than room temperature.

2. If you obtain 4.0 cm of magnesium ribbon predict the theoretical volume of hydrogen gas produced. (Mass of magnesium ribbon is 0.871g/meter)

Procedure:

1. Measure a piece of magnesium ribbon 4.0 cm long. Do not exceed 4.0 cm. This strip has been pre-measured so that it will not produce more hydrogen than the collection tube will hold.

2. Determine the mass by using the conversion factor of 0.871 g/m of magnesium ribbon.

3. Produce and collect the hydrogen gas as follows: Claim a gas collection tube (already set up in the lab). Fold up the magnesium ribbon into a small, tight bundle. Tie it with a piece of thread that is 10 to 15 *cm* long.

4. Add about 10 *mL* of 6.0M HCl to the gas collection tube. **CAUTION**. *Be sure to use* ***hydrochloric*** *acid; others might react violently when the water is added.* Then fill the tube completely with tap water, until it is nearly overflowing.

5. Place the magnesium in the mouth of the tube so that it is about 3 *cm* below the surface of the water. Fold the thread extension over the side of the tube. Insert a one- or two-hole stopper into the opening so that the cage is held firmly in place.

6. Holding your finger over the stopper hole(s), invert the tube into a 400 *mL* beaker that is about half-filled with water. Then clamp the tube in place as shown in the diagram, with its mouth below the water's surface. (There is no need to rush this maneuver. The acid will take more than a minute to diffuse down to the stopper, and by then it becomes dilute enough not to harm your finger.

7. Observe the reaction. When no more hydrogen bubbles are visible, the reaction is complete. Wait an additional 5 minutes so that the hydrogen gas comes to room temperature.

8. Cover the hole in the stopper with your finger and transfer the tube to a large cylinder or battery jar filled with water. Lower or raise the tube until the liquid level on the inside of the tube is the same as the outside. Record the volume of the hydrogen gas. (Be sure to read the liquid level at eye level.)

9. Record room temperature. Obtain the vapor pressure of water from the table. Record.

Temperature (°C)	Vapor Pressure (mmHg)
18	15.0
19	16.5
20	17.5
21	18.7
22	19.8
23	21.1
24	22.4
25	23.8
26	25.2
27	26.7
28	28.3
29	30.0

10. To find the partial pressure exerted by the hydrogen, you must recognize that the atmospheric pressure equals the partial pressure of hydrogen gas in the tube (when the water levels are equal), plus the partial pressure of water vapor mixed with the

hydrogen (according to the equation below).

$P_{atm} = P_{H2} + P_{H2O}$

11. Record today's atmospheric pressure and temperature.

12. Using the combined gas law equation (shown below), convert your measured volume of hydrogen (from Step 8) to conditions of STP, 1 atm pressure and 0 °C (273 K). Give the result in units of liters (*L*).

$P_1 V_1 / T_1$ (today's conditions) $= P_2 V_2 / T_2$ (STP)

13. Compare your experimental hydrogen volume (adjusted for partial pressure of water and current pressure and temperature) to the theoretical value by calculating the percent yield.

Data Table

1. Mass of magnesium strip	
2. Room temperature (T_1)	
3. Atmospheric pressure	
4. Volume of the hydrogen (V_1)	
5. Partial pressure of the water	
6. Partial pressure of hydrogen gas (P_1)	
7. Volume of Hydrogen collected, adjusted to STP (V_2)	
8. Standard temperature (T_2)	
9. Standard Pressure (P_2)	
10. Percent Yield	

CALCULATIONS:

DISCUSSION:

1. **There are other alternative ways to determine the theoretical volume of hydrogen production.**

   PV = nRT is another option. Because the molar ratio of magnesium to hydrogen gas is 1 to 1, if you know the number of moles of magnesium that reacted, you also know the number of moles of hydrogen gas.

   a. **Mass of magnesium:** _____

   b. **Moles of magnesium:** _____

   c. **Moles of hydrogen gas:** _____

   d. **Volume of hydrogen gas:** _____ **(Theoretical yield)**

2. **Discuss at least two reason that you had an actual yield that did not match the theoretical yield.**