Name_____

Lab # 3: Gases

PURPOSE: This lab activity will help you increase your understanding of the properties of gases, the ideal gas law, chemical reactions, percent yield, and stoichiometry. It will also introduce you to a method in which a gaseous product of a chemical reaction is collected and quantified.

PROCEDURE:

1. **PUT ON PROTECTIVE GLOVES, SAFETY GOGGLES, AND YOUR LAB COAT.** Fill the largest beaker in your drawer (600mL beaker) about 2/3 full of water and allow it to sit on the base of a ring stand so that the temperature of the water will adjust to room temperature. Connect the buret clamp to the ring stand's vertical pole. The buret clamp should be about 8-10 inches above the beaker.

Figure 1
Illustration of the magnesium ribbon coil tied to the end of a thread.

2. Obtain a piece of magnesium ribbon from the back counter of the lab room. **Weigh and record the mass of the magnesium ribbon in your data table on page 3.** Your magnesium should have a mass no larger than 0.0450 g. Roll the magnesium ribbon into a loose coil. Obtain a piece of thread (about 8 inches in length) and tie the magnesium coil to the end of the thread (see Figure 1).

3. Get a eudiometer. Always carry a eudiometer in a vertical position. The eudiometer will contain water. Completely empty the water into your sink and temporarily attach it to the buret clamp, open-end up.

4. Using a glass funnel, add about 10 mL of hydrochloric acid (HCl dissolved in water) to your eudiometer. Next, add enough water to the eudiometer to fill it completely. Reattach the eudiometer to the buret clamp, open-end up.

5. Obtain a one-hole rubber stopper from the back counter. Lower your magnesium coil into the water of the eudiometer to a depth of about one inch. Have the thread attached to the coil hanging over the lip and out of the eudiometer. Insert the one-hole rubber stopper into the eudiometer so the thread is lodged firmly against the edge. A bit of water should leak from the hole in the stopper. An illustration of the assembled eudiometer is shown in Figure 2.

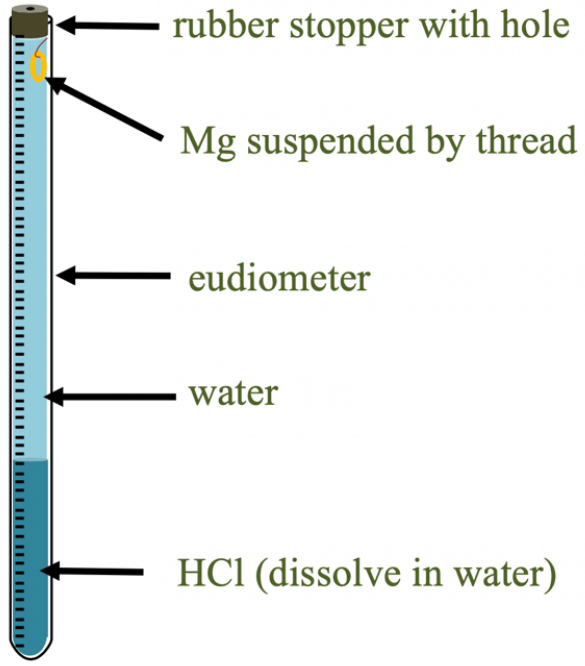

Figure 2
Illustration of the assembled eudiometer

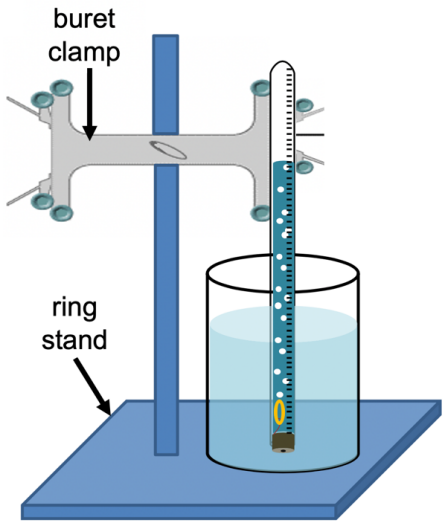

Figure 3
Inverted eudiometer illustrating gas collection and water displacement

6. Remove the eudiometer from the buret clamp, place your finger over the hole in the stopper, and then **invert the eudiometer** so that the stopper is on the bottom. Submerge the stoppered end of the eudiometer into the water, keeping your finger on the hole until the stopper is completely underwater. Re-clamp the eudiometer to the buret clamp so that the bottom of the eudiometer assembly is about two inches below the surface of the water in the beaker. **Be sure that the stopper is not touching the bottom of the beaker.** The hole must be unobstructed so that the gas that is formed in the reaction can displace some of the liquid that is inside of the eudiometer. Because the acid is more dense than pure water, it will move downward inside the eudiometer and react with the magnesium. (see Figure 3).

7. When the magnesium has disappeared entirely and the reaction has stopped, tap the tube with your finger to dislodge any bubbles you see attached to the side of the eudiometer. Measure the temperature of the water in your beaker; assume that this is the temperature of the gas in the eudiometer. **Record the temperature, to the nearest 0.1 °C, in your data table.**

8. Place your finger over the hole in the stopper (under water in beaker) and remove the eudiometer from the beaker. **Keep your finger on the hole.** Take the eudiometer to the **leveling tank**. With your finger still covering the hole, submerge the stoppered end of the eudiometer in the leveling tank water, keeping your finger on the hole until the stopper is completely underwater. Lower the eudiometer until the water level inside the eudiometer is the same as the water level in the leveling tank. **Read the volume of gas in the eudiometer and record it in your data table. Record the volume to the nearest 0.01 mL.**

9. Using the barometer that is mounted on the wall in the lab room, find the atmospheric pressure in the room. **Record the pressure in your data table.**

10. Based on the temperature you measured earlier, **record the value for the vapor pressure of water in your data table.**

Temperature (°C)	Vapor Pressure of Water, P_{H_2O} (Torr)
16	13.5
17	14.5
18	15.5
19	16.5
20	17.5
21	18.7
22	19.3
23	21.1
24	22.4
25	23.8
26	25.2
27	26.7
28	28.3
29	30.0

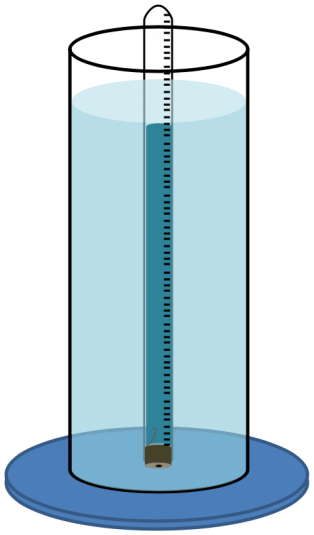

Figure 4.
Illustration of the inverted eudiometer in the leveling tank at a depth where the water level inside the eudiometer is the same as the water level in the leveling tank.

11. When finished with the experiment, pour the liquid that is inside the eudiometer into the liquid in waste container *in the hood*. Using your squirt bottle, rinse the eudiometer, pouring the waste into the liquid waste container. Repeat this waste disposal and rinsing method to empty and clean your 600 mL beaker.

12. Refill the eudiometer with deionized water and return it.

DATA TABLE:

Be sure to include the correct units when recording all of the values in this table.

Mass of Magnesium Metal **(must be less than 0.0450 g)**	=
Volume of Gas	=
Temperature of Gas = Temperature of the water	=
Atmospheric Pressure in the Room	=
Water Vapor Pressure (at the above temperature, see table on the previous page)	=

CALCULATIONS and QUESTIONS:

1. Calculate the ***theoretical yield*** of H_2 gas (# moles H_2).

   Hint: See how you did this, in the prelab assignment.

   # moles H_2 = _____ (theoretical yield of H_2)

2. ***Experimental yield*** of H_2 gas (# moles H_2).

   a) The gas that is collected in the eudiometer is *a mixtur*e of H_2 and H_2O vapor. Determine pressure of the H_2 (only, $\mathbf{P}_{H_2}$) by subtracting the vapor pressure of water ($\mathbf{P}_{H_2O}$) from $\mathbf{P}_{total}$. Recall that $\mathbf{P}_{total}$ is the atmospheric pressure in the room and is *also equal* to the pressure in the eudiometer.

   $$\mathbf{P}_{H_2} = \mathbf{P}_{total} - \mathbf{P}_{H_2O}$$

   Use the table provided on the previous page to find the vapor pressure of water.

   $\mathbf{P}_{H_2}$ = _____ Torr

   Convert this pressure from Torr units to atm units (760.0 Torr = 1atm)

   $\mathbf{P}_{H_2}$ = _____ atm

b) Calculate the ***experimental yield*** of H_2 gas (# moles H_2).

Hint: Use the Ideal Gas Law to calculate the number of moles (n) of H_2 that were produced experimentally (***experimental yield***). Make sure to use the correct units so that they match the units in the gas constant (R).

3. Calculate the ***percent yield***.

$$\textbf{\textit{percent yield}} = \frac{experimental\ \#\ moles\ H_2}{theoretical\ \#\ moles\ H_2} \times 100\ \%$$

% Yield =_____

If your percent yield is not between 90% and 110%, see your instructor; you may have made an error in your calculations.

4. What are the possible sources of error in this experiment?

5. **Every** numerical value used in this lab report should also have a **unit**. This applies to values in the data table, **ALL** values written in your equations, and numerical answers. Do you have **units** with all of your numerical values?

Circle your answer: YES NO