# Molar Volume of a Gas Lab

### Introduction

When magnesium metal reacts with hydrochloric acid, hydrogen is produced. The gas can be collected in a eudiometer where its volume may be determined. Knowing the number of moles of magnesium used, we can calculate the volume of hydrogen produced per mole of magnesium consumed. The balanced equation for this reaction allows us to determine the volume of one mole of gas at standard temperature and pressure. After completing this experiment, you should be able to determine the molar volume of a gas. You will also collect this gas by water displacement and make a standard pressure and temperature comparison to the actual value.

Objective You will determine the molar volume of a gas, and compare it to the accepted value of 22.4 L/mole at STP.

### Equipment

one 800 mL beaker one 10 mL graduated cylinder one Eudiometer (Gas Collecting Tube) one piece of Mg ribbon between 3 and 4 cm. one thermometer one hole stopper for Eudiometer.

### Procedure

1. Prepare a table using the guide in Data and Analysis.

2. Fill your 800-mL beaker two thirds full of water. If possible use room temperature water.

3. Obtain a piece of Mg ribbon from your teacher. Make sure it has a length between 3 and 4 cm. Measure the mass of the Mg as precisely as possible.

4. Wrap the Mg in the copper wire so that it won't just float tot the top of the water while reacting.

5. Fill the 10 mL graduate full of concentrated HCl. Transfer all of the acid to the eudiometer.

6 . While holding the eudiometer in a tipped position, very slowly pour water from a beaker of water into the eudiometer, being careful to layer the water over the acid so that they do not mix. Add enough water to completely fill the eudiometer.

7. Place the Mg ribbon into the acid-water mixture. Quickly put the one-holed stopper on. With your finger covering the hole on the stopper, invert the eudiometer and place it in the 800-mL beaker, being careful not to allow bubbles in the eudiometer. Clamp the eudiometer leaving it 2 cm from the bottom of the beaker. The acid will flow down the cylinder until it reaches the Mg and the reaction will start. Make sure all the Mg has reacted with the acid before removing the test tube from the beaker. If the Mg should float to the surface, gently shake the eudiometer until all the magnesium has reacted. If the magnesium gets caught on the sides of the eudiometer, call your teacher over. He will show you how to continue the reaction.

8. While the eudiometer is sill inverted in the beaker, record the volume of the hydrogen and water vapor produced. Uncork the stopper and let the rest of the water -acid run out. Dump out the water in the 800 mL beaker.

## Data

Prepare a table for your data using the following as a guide.

- a) Mass of Mg used \_\_\_\_\_g.
- b) Number of moles of Mg used \_\_\_\_\_moles.
- c) Volume of H<sub>2</sub> & H<sub>2</sub>O gas collected.\_\_\_\_mL
- d) Temperature of H<sub>2</sub> collected over water.\_\_\_\_<sup>o</sup>C
- e) Measured Atmospheric Pressure in Lab \_\_\_\_\_mmHg
- f) Vapor Pressure of water\_\_\_\_mmHg
- g) Partial pressure of the H<sub>2</sub> gas \_\_\_\_\_ mmHg
- h) Volume of  $H_2$  converted to STP \_\_\_\_\_ mL = \_\_\_\_\_ L
- i) Measured Molar volume of H<sub>2</sub> at STP \_\_\_\_\_ L/mol
- J) Accepted Molar Volume at STP\_\_\_\_\_ L/mol
- K) Percent Error. \_\_\_\_%

#### Analysis

1. Using the mass of Mg taken, calculate the number of moles of Mg used. <u>g Mg / 1 mole Mg</u> = \_\_\_\_\_ moles Mg / 24. 305 g Mg

2. Calculate the partial pressure of the H2 produced.

(e) Measured Atmospheric Pressure in Lab - (f) Vapor Pressure of water = ? Partial pressure of the  $H_2$  gas (g)

3. Convert the volume of H<sub>2</sub> produced to STP by use of the following: (answer goes in letter h)

 $\frac{\text{(c)Volume of } H_2 \text{ and } H_2 \text{O} \text{ x (g) Partial Pressure of the } H_2 \text{ gas}) = \frac{(? \text{ Volume } H_2 \text{ at STP}) (760.0 \text{ torr})}{(273 \text{ K})}$ 

4. Convert the volume of  $H_2$  produced in mL to L (answer goes in letter h) <u>ml / 1L =</u> \_\_\_\_L (h) / 1000mL

5. Calculate the molar volume of H<sub>2</sub>. That is the volume per mole. You must use Liters.

(h) Liters of  $H_2$  Produced = Molar Volume (b) # of moles of Mg

6. Calculate the percent error. (i) - 22.4 L/mole = % error 22.4 L/mole

#### Conclusions

1. Why does the acid flow down the test tube when it is inverted?

2. Write a balanced equation for the reaction between Mg and HCl.  $\underline{Mg}_{(s)} + \underline{HCl}_{(aq)} \rightarrow \underline{H2}_{(g)} + \underline{MgCl}_{2(aq)}$ 

3. How does your experimental value for the molar volume compare with the actual (22.4 L / 1 mole)?

4. Discuss all sources of error in this lab. You should discuss at least three sources of error.