Molar Mass of Hydrogen Gas

H_2

Laboratory Objectives

- To collect and measure a volume of H_2 produced from an acid-metal reaction
- To examine the metal-acid reaction of magnesium + hydrochloric acid
- To formulate a balanced equation for the experiment
- To calculate a molar gas quantity using the ideal gas formula
- To learn about the issues relating to collecting a gas by water displacement
- To learn how to remove the water component of a gas mixture through a pressure calculation

Introduction

When magnesium metal reacts with hydrochloric acid, hydrogen gas is produced. The volume of this gas can be measured by using a ***eudiometer***. Knowing the mass of magnesium used, we can calculate the volume of hydrogen gas that should be produced. The balanced equation for this reaction allows us to determine the mole ratio between the reactants and products and therefore compare the magnesium reacted to the volume of hydrogen gas produced. By measuring the volume, temperature, and pressure of the hydrogen gas that we collect, we can calculate the moles of gas actually produced by using the ideal gas formula.

.Magnesium is the least dense of the structural metals. Because it is so light-weight, it is often alloyed with aluminum and used to make custom-designed racing car wheels, called MAG wheels. Both magnesium and aluminum are very reactive with acids, such as with the hydrochloric acid used in this experiment. This explains why manufacturers of these very expensive wheels warn consumers that the use of any acid cleaning product will affect the surface and void the warranty.

Learn more about magnesium at:

http://www.minerals.org.au/education/secondary/secondary_resources/factsheets/magnesium

http://www.speclab.com/elements/magnesium.htm

http://en.wikipedia.org/wiki/Magnesium

Safety

Wear safety goggles and an apron. Hydrochloric acid is very CORROSIVE.

Apparatus & Materials

- Beakers, 400 & 50 mL
- Analytical Balance
- Thermometer or temperature probe
- 1000 mL graduated cylinder
- eudiometer
- support rod
- clamp
- rubber stopper, #00-1hole
- cm ruler
- scissors
- thread
- Mg ribbon
- 6.0 M HCl

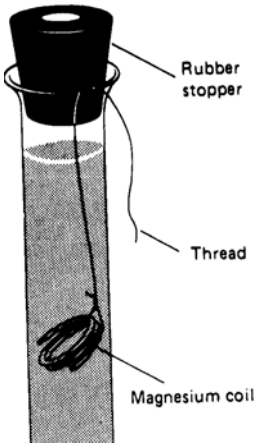

Figure 1

Procedure

1. Plug a temperature probe into the LabPro channel 1, turn on the computer, launch the LoggerPro software, look at the temperature reading on the screen to be sure the thermometer is reading a current temperature. The room temperature will be somewhere between 20 and 25 celsius. Record the room temperature reading as well as the current barometric pressure for our location (find this on the internet).
2. Fill a 400 or 600 mL beaker 2/3 full of water. Make the temperature of the water as close to room temperature as possible.
3. Cut a length of Mg ribbon between 2.0 and 2.5 cm. Determine its mass to the nearest **0.0001 g** (use the analytical balances).
4. Roll the length of Mg ribbon into a loose coil. Tie it with one end of a piece of thread approximately 25 cm in length. Tie the string so that the loops of the coil are all tied together.
5. Obtain 10 mL of 6.0 M hydrochloric acid in your 50 mL beaker. **CAUTION! HYDROCHLORIC ACID IS CORROSIVE TO SKIN AND EYES. AVOID BREATHING THE VAPOR. MAKE CERTAIN YOU ARE WEARING GOGGLES. IF ANY ACID SHOULD SPLASH ON YOU, IMMEDIATELY FLUSH THE AREA WITH WATER AND REPORT THE INCIDENT TO YOUR TEACHER.**
6. Add 3 drops of green food coloring to the acid in the beaker and note any observations. Carefully pour the 10 mL of 6.0 M hydrochloric acid into a eudiometer.
7. While holding the eudiometer in a slightly tipped position, very slowly pour distilled water from your 100 mL beaker into the eudiometer being careful to layer the water over the acid so that they do not mix very much. The color of the acid solution should help with this process. Be sure to add enough water to fill the eudiometer completely.
8. Lower the Mg coil into the water in the eudiometer tube to a depth of about 5 cm. Insert the 1-hole stopper into the eudiometer to hold the string in position. See figure 1. The stopper should displace some water from the tube to ensure that no air is left inside the tube.
9. Cover the hole of the stopper with your finger, and invert the eudiometer into the 400 or 600mL beaker of tap water. Clamp the eudiometer tube into position on the ring stand, as shown in figure 2. The acid will begin to flow down the tube and react with the Mg.
10. When the Mg has disappeared entirely and the reaction is complete, cover the stopper hole with your finger again and carefully transfer the eudiometer tube to a 1000 mL graduated cylinder or other tall vessel that has been filled with water. Be sure that no water escapes from the eudiometer tube during this transfer process. Adjust the height of the eudiometer tube inside the cylinder until the water level in the eudiometer is exactly the same as that in the cylinder. Read as accurately as possible the volume of gas in the eudiometer and record this reading. See figure 3.
11. You may now empty all of your containers into the sink. Rinse everything with clean water and return the items to their proper location.

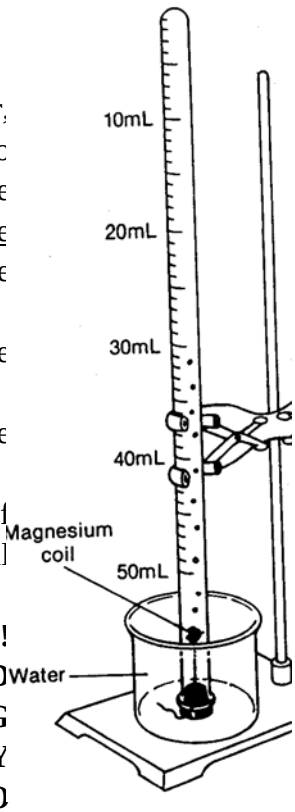

Figure 2

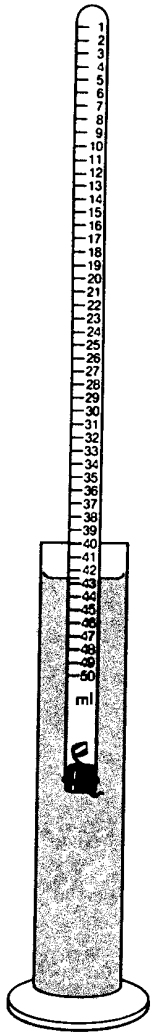

Figure 3

Report Sheet Molar Mass of Hydrogen Gas

Name_____**Date**_____

Data Table

Create a data table to accommodate all of your numeric data in this lab and attach it to this sheet.

Calculations

Show all of your computations. Be sure to include all labels and units on your values.

Place your calculation work on the back of this sheet. Show the following calculations:

1. Write the balanced equation for the reaction between the Mg and the hydrochloric acid.
2. Using the known mass of Mg, calculate the theoretical number of moles of H_2 gas that should be produced, and the theoretical mass in grams that should be produced. (stoichiometry)
3. Convert your barometric pressure into "station pressure". This is the actual pressure at our location. Go to: http://www.4wx.com/wxcalc/stationpressure.php ; Enter your elevation and barometric pressure in the left-hand column and click "convert." It will generate your station pressure in the right-hand column.
4. Consult the table of "Water Vapor Pressure Below 100^{o}C" and determine the vapor pressure of water at the room temperature during this lab. Using this value, calculate the partial pressure of the hydrogen gas collected in the eudiometer. (Dalton's Law of Partial Pressures) Convert this pressure into atmospheres.
5. Using the ideal gas formula, calculate the moles of hydrogen gas collected. Use the partial pressure of the hydrogen, the room temperature, and the volume of the collected gas (in liters).
6. Calculate the % error for your lab measurement of moles. Consider the stoichiometric moles to be the 'accepted value' and the ideal gas calculation moles (n) to be the 'observed value.'
7. Calculate the experimental molar mass of hydrogen gas. Use the theoretical mass in grams of H_2 (calculation #1) divided by the actual number of moles H_2 (calculation #4).

Questions (answer on your own paper and attach to this sheet)

1. Why does the acid flow down the tube?
2. What happens to the concentration of the acid as it flows down the tube?
3. Describe your observations of the movement of the acid.
4. Describe your observations of the reaction of the acid and the metal ribbon.
5. How is the pressure of the gas inside the eudiometer determined in this experiment?
6. What is the purpose of making the levels of liquid the same height in step 10 of the procedure?
7. Why is it necessary to make a "water vapor pressure correction" of the barometric pressure in this experiment?
8. Give at least two reasons for the % difference you obtained in this experiment.
9. For the past 100 years, some cooking pots and pans have been made out of aluminum-magnesium alloys. What will be the effect of placing acidic foods or liquids into these pans?
10. What are two or three examples of foods that will react with these metal pans?

Write Balanced Equation Here:

Show Calculations Here: