Experiment 5
Reaction of Magnesium with Hydrochloric Acid

OUTCOMES

After completing this experiment, the student should be able to:

- develop a procedure for generating and measuring a gas in a reaction.
- develop a relationship between the mass of magnesium reacted and the volume of gas generated.
- acquire an understanding of limiting reactants.

DISCUSSION

There are many questions which we want to answer in science. However, in order to answer them, we need to have data appropriate to the questions posed. A large part of getting the data is designing an experiment which can focus on the variables being studied and accurately collect the information to analyze. This experiment will be an opportunity for you to design an apparatus to collect hydrogen gas formed in the reaction between magnesium metal and hydrochloric acid. In addition, you will use the information to determine the limiting reactant in the reaction.

MATERIALS

Plastic bin	Test tube (25 x 200 mm)	Pipet filler
100 mL graduated cylinder	1-hole rubber stopper	1.0 *M* HCl
Ringstand and clamp	Glass bend	0.5 g Mg ribbon
Rubber hose	5.00 mL pipet	Tap water

PROCEDURE

⚠ ***Wear safety glasses or goggles at all times for this experiment.***

⚠ ***Avoid skin contact with hydrochloric acid. Rinse skin thoroughly if contact is made.***

⚠ ***Never pipet by mouth.***

⚠ ***Hydrogen gas is flammable.***

⚠ ***In order to prevent pressure build-ups, make sure that there are no kinks in your rubber hose.***

You will work in groups of 3 to 4, assigned at random or by the professor. One member of the group will be assigned as a project manager; one as a computer operator; one or two as laboratory technicians. See the group work page for more information.

1. Design an apparatus that will enable you to collect and measure the volume of hydrogen gas generated using only materials found in the list above. To facilitate speedy collection of the data, your group may choose to set up two separate sets of equipment. Make sure to check your system(s) for leaks or cracks.

2. React eight different masses of magnesium in the range of 0.01 g to 0.10 g with exactly 5.00 mL of 1.0 *M* HCl. *To the extent possible, try to spread the masses of magnesium evenly over the entire range of 0.01 g to 0.10 g*. Use an analytical balance to record the masses.

3. For each trial, collect the hydrogen gas until there is no more than one bubble produced per minute.

4. For each trial, record the mass of magnesium you used, the volume of hydrogen generated, and make note if any magnesium metal remained at the end of the reaction.

5. Repeat any suspicious trials.

⚠ ***Dispose of all chemicals in the proper waste container.***

DATA ANALYSIS

1. Create a data table in *Excel* with the data obtained from the experiment.

2. Using *Excel*, prepare a graph of the volume of hydrogen gas generated vs. the mass of the magnesium used, plotting only the points (do not connect the dots).

3. Which reactant, if either, is the limiting reactant when smaller masses of magnesium are used? When larger masses of magnesium are used? Use the concept of limiting reactants to explain the shape of your graph.

4. Using the necessary data from your results, use *Excel* to develop a mathematical relationship between the grams of magnesium reacted and volume of hydrogen produced.

   Note: Use only the points that make an approximately straight line. If there is more than one linear portion on your graph, plot a trendline for the portion of the graph that is not "level." If there is a "level" portion of the graph, you may use the average value of the data points for the relationship.

5. Using the relationships developed in question 4, how many milliliters of hydrogen would be produced if 0.0400 g of Mg had been reacted with 5.00 mL of 1.0 *M* HCl? What if 0.0800 g of Mg had been used? 0.120 g of Mg?

6. Write a balanced chemical equation, including phase labels, of the reaction that took place in this experiment. Consult your text, if necessary. *Hint: This is a single replacement reaction where one element is replaced by another in a compound (ie: A + BC → B + AC).*

7. Using your balanced equation, calculate the theoretical yield of hydrogen gas, in mL, that should be produced at a temperature of 0 °C and a pressure of 760 mmHg when 0.0400 g of Mg reacts. *Note: 1 mol of any gas at a temperature of 0 °C and a pressure of 760 mmHg has a volume of 22.4 L.* How does this result compare to the volume calculated for 0.0400 g of Mg in question 5?

8. How would your results and your graph change, if at all, if the concentration of HCl was 2.0 *M* instead of the 1.0 *M* used in this experiment?

9. There were, as in all experiments, some "uncertainties" in this lab. Explain some actual causes of error and/or inaccurate measurements. How could you design a future experiment to eliminate there errors or inaccuracies?

POSTLAB ACTIVITY

You will be turning in a group lab report. The report should include the title, procedure, results, discussion, and references. The information that you obtained from the data analysis should be included at some point in the report. It is up to you whether it is in the results or discussion or both. However, remember that the report is more than just answering some questions and that it should flow smoothly and logically as you discuss the data obtained and what it signifies. You do have the option of including the answers for questions 5 and 7 in an appendix at the end of the report if you cannot work it smoothly into the results and discussion. Lab report guidelines for how to write the procedure, results, and discussion are found at http://webs.anokaramsey.edu/chemistry/Chem1061.

Follow your instructor's directions for submitting the report. If you are submitting electronically, please submit a single file with all of the required information. Use the following convention for naming your files: *Lastname1 Lastname2 Etc Limiting Reactant*. If you are emailing the report, use a subject line of *Chem 1061: Limiting Reactant Lab*.

You will need to show sample calculations in the report. For electronic submissions, you may embed data tables which contain the formulas in calculated cells. For paper submissions, you will need to show these calculations for one trial of each reaction. You will also need to show

these calculations if you submit the report electronically but do NOT include formulas in embedded data tables.

As this is a group report, please include a table at the end showing the percent contribution of each group member on the entire lab, including the report.