**CHEMISTRY 129**

**Experiment 9**

**Design Lab: The Reaction of Magnesium with Aqueous Acids in the Presence of Salts**

**Reference:** Gillespie, *et al.,*  Chapter 5.

**Introduction**

 For most of the experiments in this course, detailed instructions are provided and well tested procedures are employed. The emphasis is on doing accurate work, learning sound techniques, and learning principles of chemistry in the course of doing a variety of kinds of quantitative experiments. This “Design Lab” is included to provide an opportunity to undertake a more realistic--albeit still quite specific--problem.

 Typical problems that scientists encounter do not come with well worked out instructions for solutions. However, the following steps are involved in a systematic approach to solving any technical problem:

1. Clarifying what the problem is--asking the right questions--is usually the most important step in the process.
2. When questions can be clearly articulated, an experiment (or experiments) can be devised to answer the questions.
3. Carrying out the experiments to produce some observations and data. The data typically require some manipulation to get them in a form consistent with the questions posed. Complicated experiments often require several attempts before all of the "bugs" are worked out. Even simple experiments usually don't go right the first time.
4. When repeated experiments yield the same result, reliable conclusions can be drawn from the data--the questions posed in step 1 can be answered.
5. The final stage in any scientific investigation is the communication of the data and conclusions--writing the report. The experiments and conclusions are of little value until they are communicated effectively to an appropriate audience.
6. All of the steps necessary to solve a problem are included in this assignment.

 **The Problem.** Magnesium metal is known to react with aqueous acids to produce hydrogen gas and a magnesium salt. Both the rate of production of hydrogen and the total volume of hydrogen gas can be influenced by the presence of other salts. In general terms, the problem is to explore quantitatively the effects of acid concentration and added salt on the rate and amount of hydrogen gas produced in a reaction between Mg and acids.

 The following questions are posed to limit and focus the investigation more clearly:

 1.How do the rate and the amount of hydrogen gas obtained in the reaction of Mg with HCl vary with [HCl]?

 2. How do the rate and the amount of hydrogen gas obtained in the reaction vary with the concentration of added salts when magnesium dissolves in 1.0 M HC1?

 Several salts will be available. Your group should examine two of them.

**Experimental**

 **Operational details.** The project is to be a collaborative one with all students in the group contributing to the actual experimental work and the writing of a single composite report. Groups of four students will be identified by your instructor before the first lab period devoted to this experiment.

 You previously used an apparatus for collecting gas at atmospheric pressure. It resembles the apparatus you used to determine the molecular weight of a gas in Experiment 4. You should think about how to modify the apparatus and its use to collect information about the rate of the reaction. You might want to divide up the experiments so that your group is collecting data in parallel. Your group should pool its data and analysis and then prepare a composite report.

 **Planning the experiment.** You should first discuss procedural details with your group and the laboratory instructor. After these initial discussions, try a preliminary run to become acquainted with the apparatus. After this has been done, a plan of work can be suggested. There is no one plan that is “correct”, although some approaches may be superior to others. As you do your work and make observations, please discuss your problem with other students and consult with your laboratory instructor as needed. Complete interchange of ideas and observations is encouraged throughout the project.

**Report**

 The group should submit one paper which discusses all of the experimental work and overall conclusions. Your report should consist of the following sections:

 a. Cover page. This should include a title, the names of the students in your group, the date, and your section (Mon PM, etc.). Also include a table summarizing the percentage of the total effort (100 %) contributed by each student to a) carrying out the experiments, b) analyzing the data, and c) preparing the composite report.

 b. Introduction.. This should be a clear statement of the questions that your group addressed and the general approach used in the experiment.

c. Experimental procedure. This section should describe clearly the procedure used in the experiment. This section should be written in the third person past tense. Enough detail should be included so that the experiment could be repeated by another investigator. A sketch of the apparatus used would be appropriate.

d. Results. The results are most succinctly presented in tables, labeled Table I, II, etc. (with a descriptive caption), and graphs labeled Figure 1, 2, etc. Details to be observed in preparing such graphs are spelled out in the document Graphing Standards included in your lab manual. In addition, a narrative description of the contents of the tables and graphs should be included.

e. Discussion. This section should discuss the significance of the results, interpretation of the data and a general evaluation of the procedures used.

f. Appendix. Include a sample calculation for each type of calculation here.

 Length of report. The text of the report, exclusive of tables, figures, drawings and appendix should not exceed four (4) double spaced pages.

 Writing style. The report will be evaluated on the basis of both content and presentation. Pay careful attention to your writing style, sentence structure, spelling, etc. Avoid use of the first person and the imperative form in describing procedures. (Two grams of KNO3 was (not were) added to 20 ml of water...not I added 2 grams of KNO3 to 20 ml of water...or add 2 grams of KNO3 to 20n ml of water.) Use of major headings and subheadings, as illustrated in these instructions, can help to organize the presentation.