CHEMISTRY 030.305

Professor Howard Fairbrother

PHYSICAL CHEMISTRY INSTRUMENTATION LABORATORY

GENERAL INFORMATION

1. Hours:

Lectures will be given on Mondays, 1:30 to 2:20 p.m., Remsen 140. The first topic will be analysis of experimental errors and will follow the treatment of Taylor, *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements.* Problems from the ends of the chapters in this text will be assigned and checked. During the first week of class, lectures on the background for each of the experiments will be presented during the Monday and Wednesday laboratory periods in Remsen 140. The experiments will be carried out during the hours of 2:30 p.m. to approximately 6:30 p.m.:

Section 1 — Monday afternoon
2 — Wednesday afternoon

No one is permitted in the lab in non-scheduled hours, and no experiments may be done after lab hours.

2. Grading:

Your grade will be determined from the following:

25% from the total score on preliminary lab reports and data taken in the lab.
50% from the total score on the final lab reports.
25% from the homework assignments from the text by Taylor.

There will be no final examination.

3. Laboratory Rules:

1. Safety glasses and closed toe shoes must be worn at all times when in the laboratory.
2. No eating, drinking, or smoking is permitted inside the laboratory.
3. Use the coat rack for coats and jackets.
4. Please step outside of the laboratory to talk to visitors.

4. Make-up Labs:

In certain cases (religious holidays and scheduled interviews, sports events, or medical treatments) make-up labs can be scheduled when the regularly allotted time for an experiment will be missed. Please inform Dr. Fairbrother, the relevant T.A., and your teammate of any such conflicts so that arrangements can be made for a make-up time. In the case of serious, unexpected illness, you must notify Dr. Fairbrother and your teammate of your absence and provide a medical excuse at the next class attendance. In case of equipment failure during an experiment, a make-up or substitute lab will be scheduled. ***No more than two make-up labs will be scheduled for any student.***

Final Reports. Each student writes a final report *independently*, based on jointly collected data. Part I of Shoemaker *et al.* discusses report writing and gives examples. Please follow these guidelines:

1-2 pages - title and abstract, introduction (purpose and theory), experimental method.
1-6 pages - results (figures and tables).
1-4 pages - error analysis and discussion.

Please be concise - not more than 12 pages will be accepted for grading. ***Finished reports are due in the hands of the responsible T.A. by the end of the lab period (6:30 p.m.) two weeks after the experiment was performed. Do not procrastinate or ask the T.A.'s for more time. There will be a 5-point reduction in the grade for each week that a report is late - no exceptions.***

Dr. Fairbrother or the T.A.'s are available to discuss general questions pertaining to the experiments. Every effort will be made to return graded reports in the next laboratory week.

Nota Bene

It is very important that each student come to class prepared to do their scheduled experiment. You must study the handout and textbook beforehand in order to have a grasp of the theoretical background, experimental procedures, and how you will do an error analysis. ***The T.A. is there to assist - not lead you through - an experiment!***

5. Proper Attire For Individuals In Laboratories:

It is the policy of the Johns Hopkins University that all employees, faculty, students and visitors wear appropriate attire in all laboratory areas to eliminate or minimize skin contact with hazardous materials. Shorts, miniskirts or any apparel that does not cover the skin above the knee when seated should NOT be worn in the laboratory without appropriate over protection (e.g. a buttoned laboratory coat or closed front gown). Open toed shoes, sandals or shoes made of loosely woven material should not be worn in the laboratory. Gloves should be worn whenever there is a potential exposure of the hands to hazardous materials. The gloves should have the necessary resistance to the hazardous material being used.

6. Advice About Writing Lab Reports:

Chapter I of Shoemaker, Garland and Nibler discusses style and format for writing up your experimental lab reports, along with giving a sample report.

The abstract is a short statement of your experiment. It should tell what was measured, how it was measured and give the results along with any associated error. Do not summarize each section of your report in the abstract. Its purpose is to inform a reader of the report's subject and findings, in order to determine whether further perusal of the article is desired. It is best to write an abstract after all other sections of the report have been completed.

The introduction should state concisely the goal of the experiment and why it is of interest. What can be inferred from the measurement of this quantity? Do not give the procedure in the introduction, nor should you give all the detailed equations used in analyzing the experimental data.

In the experimental section, give a brief description of the procedure. A person unfamiliar with the experiment should be able to repeat it by following your procedure. It may also be interesting to state *why* something was done in a certain way. This will help the grader see that you understood in the lab why the experimental procedure was performed in this manner. Provide information [model number and/or specifications about the instrument(s)] used to make your measurements.

In reporting your results, you should *always* use language to present your findings. Do not give the results as a collection of Figures and Tables without any accompanying exposition. Results should be easy to find and not be buried in the text. *Do not over report the significant digits of your results.* Tables and graphs are an important way of communicating scientific information. They should be labeled Table 1, Table 2, etc., and Figure 1, Figure 2, etc. For graphs, a line should be drawn around all four sides. The independent variable should be the ordinate (x axis) and the dependent variable the abscissa (y axis). Don't put too many plots on one graph. Axes and units should be clearly labeled. Numerical values on the ordinate and abscissa should be given next to the tick marks. A legend should be given under each figure. If more than one set of data is plotted, the figure legend should note what symbol is used for each set. In some cases it may be appropriate to compare the experimental data with a calculated plot. In other cases, comparison with a least squares fit may be best. Try to find a relationship between the variables that yields a linear plot. For example, if you expect the experimental data to fit the relationship
$y = ax^2 + b$, you would want to plot y *vs.* x^2.

The reporting of a numerical result is incomplete without a discussion of its estimated experimental uncertainty. Chapter II of Shoemaker, *et al.*, provides an overview of error analysis as a starter. By the end of the course (after completing the Taylor homework) you will be expected to apply your knowledge of error analysis more stringently than at the beginning. You may also consult P.R. Bevington, *Data Reduction and Error Analysis for the Physical Sciences*. Avoid qualitative or vague statements in your analysis. Try to make quantitative statements about the uncertainties and the propagation of these errors to the final results. You should also be cognizant of the possibility of systematic errors, which cannot be inferred from a statistical error analysis. Some things will be important in affecting the errors, many not. Your discussion of the error analysis should address these issues.

The discussion should clearly state what can be inferred from the experimental results. Some experiments test the validity of simple models; be sure to assess the usefulness of these theories. The experimental results may still be good while the model may not be useful. Also, judge the usefulness of a model within the context of its expected applicability, i.e., don't dismiss a model when its prediction differs from your results by 0.1% if the model is expected to provide only 5% estimates. In some experiments there may be a large quantity of numerical results. Some may agree well with literature values, and others not. State this fact and try to give reasons for this observation. Try to be optimistic about your results. Don't always look for reasons why the experiment should (or does) fail. With care taken during measurement and analysis, most of these experiments can yield good results. Capricious explanations for explaining poor results are unacceptable.

Be sure to answer the questions asked in the handout and/or the text. Finally, be sure to give literature references as footnotes, when appropriate, numbering them sequentially in the text and listing the actual citations at the end of the report.

Texts:

D.P. Shoemaker, C.W. Garland, and J.W. Nibler, *Experiments in Physical Chemistry,* 8^{th} Ed. (McGraw-Hill, New York, 1996).

J.R. Taylor, *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements*, 2^{nd} Ed. (University Science Books, Mill Valley, CA 1997).

Science Reference (MSEL, C level):

1. H.W. Salzberg, *Physical Chemistry Laboratory: Principles and Experiments* (QD457.S31 1978).

2. H.A. Strobel, *Chemical Instrumentation* (QD79.15.S76 1973).