University of Massachusetts Boston - Chemistry Department

Physical Chemistry Laboratory General Information

Instructors & Schedule:

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Lecture: M 1:00-1:50 (Room S-1-089)
Lab1: M 2:00-5:00 (Room S-2-047) [Foster]
Lab2: Tu 2:00-5:00 (Room S-2-047) [Dransfield]

Purpose of the course:

Laboratory experiments in CHEM 314 are designed to introduce students to basic physical chemical concepts and methods, as well as to develop experimental skills in laboratory techniques that are fundamental to all areas of chemistry. Emphasis will be placed on the experimental tools used to determine material properties, including pressure, heat capacity, surface effects, colligative properties, phase and reaction equilibrium, and rate constants.

The presentation of laboratory results, including written and graphical form, will be stressed. Interpretation of basic statistics used in reporting scientific data, including concepts of accuracy and precision, significant figures, mean, standard deviation, confidence level and linear regression will be included. But the primary emphasis of the written reports will be on interpreting and explaining data, and thus obtaining scientific conclusions.

Chemistry is an **experimental** science, i.e. lab work is an integral part of the discipline. Thus, the laboratory experience in this course is designed to:

- Impart a hands-on illustration of standard wet-chemistry and instrumental analytical methods.
- Develop analytical thinking/problem solving processes and the ability to communicate those thoughts effectively to others.
- Promote team skills through cooperatively working together in small groups.
- Refine basic laboratory techniques necessary to perform analyses safely and efficiently, while attaining the highest accuracy and precision a technique will allow.
- Develop the fundamentals for reporting scientific results.

In many cases, the experimental procedures themselves are easily carried out, but transforming the data into meaningful quantitative results is not trivial. Consequently, the major emphasis in this laboratory course is placed on the theory and calculations relating to the experimental measurements, rather than the instrumentation used to obtain the data. This emphasis is not unlike the focus of research work in physical chemistry today (although instrumental design and operational technique can also be a major component).

Textbooks and Course Materials:

There is no main text required for this course. Instructions for the labs can be downloaded from http://alpha.chem.umb.edu/chemistry/ch314 the week prior to performing the experiments.

Textbooks that can be useful for specific subjects:

1) ***Experiments in Physical Chemistry,*** Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, 8th ed., McGraw-Hill, New York 2009.

2) ***Physical Chemistry,*** P.W. Atkins, J. de Paula, 8th ed. W.H. Freeman and Co, 2006.

3) ***Quantitative Chemical Analysis***, Daniel C. Harris, 5th ed., Freeman, 1999.

4) ***An Introduction to Error Analysis***, John R. Taylor, University Science Books 1982.

Grades:

Grades will be based on:

- Laboratory reports which are worth a total of **300 points** (see below for much more detail on the preparation of lab reports).
- "Quizzes" due before each lab which are worth a total of **100 points**, and will cover the material presented in the lab handout and the lecture itself. They will each consist of two short questions, designed to test your preparation for the experiment to be carried out and the analysis of the experimental data.

Based on a total of **400 possible points**, projected cutoff points for letter grades are: **A-** → **A** = ≥85%; **B-** → **B+** = 65% → 84%; **C-** → **C+** ≥50%. The final grade distribution may be more generous than this, but it will certainly not be more strict.

Attendance:

It is very difficult and sometimes impossible to schedule "make-up labs." Therefore, you must attend your assigned laboratory session. ***If you must miss a lab session for any reason, contact the Instructor as early in advance of the lab as possible, to discuss the possibility of an alternative.***

Experimental Work:

Experiments will be performed in groups of two or more students. Although data will be collected by groups of students, ***each student must write and submit his/her own report***. Collaboration in collecting and analyzing the data is perfectly acceptable, but ***if it is evident that two or more students have jointly written a lab report the grade for that experiment will be divided equally among the participants in this joint effort***.

The following points are especially important:

1. ***Each student should have a lab notebook*** in which the details of an experimental procedure and data obtained are recorded as the experiment is carried out. Your written reports should include any and all necessary observations taken during the experiment, and you will find a written record to be of great benefit. You will not be graded on this.
2. ***Each student should keep a back-up copy of his/her report***. This can be a computer file or a printout copy. Keeping a back-up copy is your insurance in case your report gets misplaced.
3. ***In the reports you are to be "true" to your data.*** Your report should reflect what **you** measured and observed; data is not to be changed or manufactured to fit expectations. If you missed collecting some data, see the instructor. Don't copy someone else's data.

4. ***Reports must be prepared with a word processor, using graphic software suitable for statistical analyses particularly linear least-squares regression, and printed on a good-quality printer (e.g., laser or ink-jet printer).*** Many current spreadsheet programs (e.g., Quattro Pro, Lotus, Excel) and graphing programs (e.g., SigmaPlot, Axum, Origin) are suitable for these purposes and are available on the Department's student-accessible computers. In addition to Departmental resources, Computing Services has personal computers and software available for student use.
5. ***Data and calculated results should be neatly and completely presented with appropriate units***. Large data sets should be presented in tabular form with clearly labeled column heads. Show sample calculations to demonstrate how you obtained your numerical results.
6. ***Numerical results must be presented with the appropriate errors and number of significant figures.*** If you are rusty on this, review your freshman chemistry text. Where appropriate, calculate standard deviations for the data.
7. ***Except for generally recognized constants (e.g., anything listed on the inside front cover of typical physical chemistry books), cite the source of any value or information you obtain from the literature.*** Occasionally students find data that are unknown to the instructor; a citation can help validate the data and your appropriate use of it.

Specifications for data analysis

Your *initial* analysis of a given lab's data is due *the next Monday before lecture.* You will email your completed Excel template to Dr. Foster. Blank templates will be posted to the course web page in advance. You **must** use the Excel template that is provided! This initial analysis will **not** be accepted late. You will receive a grade and feedback on that analysis as quickly as possible.

Your *final* analysis of the lab data will be due two weeks after the completion of the experiment, unless otherwise announced or noted in the laboratory schedule. You will email your completed Excel template to Dr. Foster. You will also *incorporate* your results in your final report (see below). This means tables and figures as appropriate. You should also *briefly* explain your analysis, but do **not** include the calculations themselves in the written report – only the results.

Specifications for laboratory reports

All Laboratory reports are due two weeks after the completion of the experiment, unless otherwise announced or noted in the laboratory schedule. Lab reports handed in late will be penalized one point, plus one additional point for each 24 hours which have passed from the deadline. Reports WILL NOT BE ACCEPTED more than one week late. In keeping with the analogy to research work, the laboratory reports in this course follow the format of published research papers in the field, as might appear in one of the standard journals (e.g., *Journal of Physical Chemistry*, *Journal of the American Chemical Society*). Reports should emulate the overall style of published work in physical chemistry, and you are encouraged to pay particular attention to the journals in the library for examples of standard scientific presentation (style, reference format, illustrations, etc). If you are not aware of the conventions of such journals, it is recommended that you go to the library to investigate. A template is available on the course web page, and is recommended reading before you begin writing your first report. You should feel free to use that template directly, or to use it as a guideline.