**CHEM 445, Physical Chemistry Laboratory I**

**Fall, 2015, 15F**

Instructor: -021L, 240 BRL, 12:20 – 4:20 We

Burnaby Munson -022L, 240 BRL, 6:30 – 10:30 We

217 BRL, 831-2917 -023L, 240 BRL, 12:30 – 4:30 Th

bmunson@udel.edu -024L, 240 BRL, 6:30 – 10:30 Th

 -025L, 240 BRL, 12:20 – 4:20 Fr

 -026L, 240 BRL, 5:00 – 9:00 Mo

 -027L, 240 BRL, 12:30 – 4:30 Tu

Grading:

 **LABORATORIES WILL NOT MEET DURING THE FIRST WEEK OF THE SEMESTER. Labs will meet beginning the Tuesday after Labor Day, 9/8/15. The first class period will include safety orientation and a brief introduction to the lab. The second week of lab will be Exp. 0, Data Analysis.**

 **The Monday lab will not meet on Labor Day, but will have safety orientation, introduction to the lab, and Exp. 0 on Monday, 9/14.**

 **Attendance at the safety orientation is required before any laboratory experiment may be done.**

 There is no text for this laboratory course. The experiments are available as PDF files under Laboratory Experiments on Sakai for students enrolled in the course. The experiments may be copied and printed using Adobe Acrobat Reader. However, a notebook containing a copy of each experiment is available at each station. You need not bring your own copy.

Definitions and calculations of standard deviations and propagation of error analyses are available in many standard works on analytical or physical chemistry (including Harris, QUANTITATIVE CHEMICAL ANALYSIS).

The CHEM/BIOC Library has standard reference works (CRC Handbook of Chemistry and Physics, International Critical Tables, Lange’s Handbook, etc.) and monographs that may contain data for comparison with your experimental data. Some Web sites (NIST, etc.) contain reliable information. Not all Web sources are reliable. A Google search occasionally provides useful information.

**Five experiments** will be done this semester in rotation:

Exp. 1 Freezing Point Depression

Exp. 2 Partial Molal Volume

# Exp. 3 Effect of Ionic Strength on the Solubility of Calcium Sulfate

Exp. 4 Heat of Combustion and Formation

Exp. 5 pKA and Ionic Strength

The experiments in this course are experiments in thermodynamics – not kinetics and quantum mechanics – and are not in sequence with the topics in CHEM 443/418. One pair of students will do each experiment each week. Consequently, there will be no “pre-lab” discussions. You must be prepared for your experiment each time.

 You will generally do each of these experiments with a partner. There will be a rotation of partners throughout the semester. The schedule will be posted for each section on Sakai and on the door to 240 BRL. Missing a laboratory period is a major problem for you and your lab partner. There are no “snow days” to make up a lab later in the semester. Make every effort possible to attend your lab section. In the event that you cannot attend, let your lab partner, the Lab Instructor, and bmunson@udel.edu know – in advance. In general, it is not possible to complete an experiment in another scheduled lab period. Lateness is an inconvenience to your lab partner.

 You have two weeks to perform each experiment and write a report. It is worthwhile to bring a laptop to lab to begin analyzing your data as you obtain it. **However, you must maintain a traditional notebook.**

 Your object in performing these experiments is to obtain reliable data for analysis. All of the experiments work and part of your grade is based on the accuracy/precision of your results.

 Even if you have obtained all of the necessary high quality data during the first lab period, **you must spend a substantial part of the second lab period in the lab analyzing your data and writing your report**. This time guarantees that you and your lab partner can meet and is an opportunity for you to ask questions about the analysis of the data from the Lab Instructor (or 75). Collaboration in writing reports consists of both partners working together on all parts – not an assignment of parts: “I’ll write the introduction and procedure; you do the data analysis.”

 It is difficult, if not impossible, to write a good laboratory report if you begin the night before it is due.

**Grading**

 Your laboratory notebook and performance in the laboratory, as evaluated by the Lab Instructor, count as 50 points, each.

 Lab performance includes preparation of the notebook before the laboratory period; attendance on time; proper lab techniques and chemical disposal; and cleaning your equipment and work area after the experiment is completed.

 The “carbon copies” of pages in your laboratory notebook will be graded at the end of each set of experiments.

 The first lab report – data analysis of previous experimental data – counts as 50 points. Each of the five experiments counts as 100 points – 80 points for the written report and 20 points for the accuracy and precision of the data. The Sakai site has detailed information about the lab reports.

 A written final exam will count as 100 points. This exam {multiple choice/short answer} covers procedures and analysis of data from the experiments. Questions from previous exams are available on Sakai.

 Lab reports are due electronically by the beginning of the lab period when the next experiment begins. You have two weeks to do the experiment and write the report. An electronic copy of your report as .pdf should be submitted via the UDEL Drop Box to the Lab Instructor grading that experiment and to bmunson@udel.edu.

 A penalty of 2 points per day, including weekends, will be deducted for late lab reports, **except under unusual circumstances** **that should be arranged with your Lab Instructor in advance.**

 **Each person should record all data in its notebook.** Be careful to save your data and analyses. At least one computer “ate the data”, no paper record was maintained, and the students had to repeat the experiment. In other cases, one lab partner did not show up for the second week and the student in lab did not have all of the data needed for analysis. Your computer may “eat your data” or have other malevolent effects no more than once during the semester without late penalty.

 The lab reports will be graded on a numerical scale. Twenty points of the grade are based on the accuracy and precision of your data. Eighty points are given for the analysis and presentation of the data.

**Tentative Course grading**

675 - 750 A

650 - 674 A-

625 - 649 B+

600 - 624 B

575 - 599 B-

545 - 574 C+

515 - 544 C

485 - 514 C-

445 - 484 D+

400 - 444 D

350 - 399 D-

**CHEM 445 Course Learning Goals**

{Numbers in parenthesis indicate the departmental goal to which each goal is applied.}

After successful completion of this course a student should be able to do the following:

1. Apply theoretical principles and mathematical analysis to the solution of problems. (1)

2. Perform experiments with modern instrumentation. (6)

3. Use computer programs for data acquisition and analysis. (5)

4. Work effectively with others in performing experiments and writing reports. (8)

5. Be able to write clear technical reports. (10)

6. Understand and practice proper laboratory safety procedures. (7)

7. Understand and practice ethically correct presentation of scientific data. (9)