

Analysis of Equilibrium Systems Laboratory
CHEM 2041
Winter Quarter, 2012

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| Instructor | Dr. Keith Miller, Associate Professor of Chemistry and Biochemistry |
| Office | SGM 105 |
| Contact info | phone: 303.871.7721; email: keith.miller@du.edu |
| Laboratory Time | Varies: see sections below |
| Laboratory Location | Olin 235 |
| Office Hours | MW 10:00 – 11:00; other times by arrangement |

REQUIRE COURSE ITEMS

| | |
|--------------------------|--|
| Lab Notebook | The lab notebook specified for the course, available in the bookstore, makes two copies as you write. One of these copies stays in the bound book, and the other is turned in as part of your lab reports. The graduate teaching assistant (GTA) must initial your lab notebook at the end of each lab session. It is your responsibility to show your notebook to the GTA and get it initialed. |
| Computer | A laptop computer will be required for this laboratory. You will be using your laptop in the laboratory every week, starting the week of January 9, 2012. <i>Please inform Dr. Miller and your GTA immediately if you do not have a working laptop computer.</i> |
| Laboratory Manual | Available on the CHEM 2011 Blackboard website. Individual sections will be available for download. You are not required to download the entire lab manual; however, you are expected to download the procedure associated with each laboratory. |
| Textbook | We will use portions of the same text that is required in the lecture, CHEM 2011. The text, <i>Quantitative Chemical Analysis</i> , 8 th ed., by Daniel C. Harris [2011, Freeman; ISBN-13: 978-1-4292-1815-3], is available at the DU Bookstore both in text and electronic versions. If you look elsewhere, use the ISBN number to make sure you have the correct version. |

BLACKBOARD

Class handouts and assignments will be available through the web on Blackboard. **Pre-labs will be submitted on Blackboard PRIOR to the start of your lab period.** Further details are found in a later section of the syllabus.

GENERAL COURSE DESCRIPTION

Analysis of Equilibrium Systems (CHEM 2011/2041) provides an introduction to chemical equilibria and kinetics. The emphasis is on aqueous solutions because of their importance in living systems and in environmental science. CHEM 2011, Analysis of Equilibrium Systems, (the lecture course) is a corequisite for CHEM 2041 (the lab course) and students who register for 2041 are also expected to register for 2011.

TEACHING ASSISTANTS

There will be a Graduate Teaching Assistant (GTA) in each lab section. These teaching assistants will have scheduled times that they will be available outside of lab to help you understand the concepts, perform calculations, etc. **PLEASE DO NOT EXPECT YOUR GTA TO HELP YOU WITH PRE-LAB CALCULATIONS JUST BEFORE THE PRE-LAB IS DUE!** They will be busy preparing for the laboratory to make sure everything is prepared for your laboratory section.

| Lab Section | Meeting Time | GTA | GTA email |
|-------------|-----------------|--------------------|------------------------------|
| 1 | Mon; 2-4:50PM | Michelle Deaton | michelle.deaton@du.edu |
| 2 | Tues; 8-10:50AM | Nitika Dewan | dewannitika@yahoo.com |
| 3 | Tues; 2-4:50PM | Philip Cheney | Philip.Cheney@du.edu |
| 4 | Tues; 6-8:50PM | Philip Cheney | Philip.Cheney@du.edu |
| 5 | Wed; 2-4:50PM | Carolyn Schumacher | carolynjschumacher@gmail.com |
| 6 | Thur; 2-4:50PM | Nitika Dewan | dewannitika@yahoo.com |
| 7 | Wed; 6-8:50PM | Carolyn Schumacher | carolynjschumacher@gmail.com |
| 8 | Mon; 6-8:50PM | Michelle Deaton | michelle.deaton@du.edu |

EXPERIMENTS

In the following table, each experiment is listed with a brief description. On Blackboard, you will find each experiment listed on the menu as a separate folder. Please make sure you follow the checklist in the folder to make sure you are prepared for the laboratory each week.

| Experiment | Description |
|------------|---|
| 1 | Check in; software installation; Introduction to analytical techniques |
| 2 | Solubility of copper salts |
| 3 | EDTA titration of Ca^{2+} and Mg^{2+} in water |
| 4 | Standardization of NaOH and HCl |
| 5 | Weak acid mixtures and polyprotic acids |
| 6 | Acid-base buffer preparation |
| 7 | Kinetics; check out |

Since there is a holiday during the quarter, the Monday laboratories will not be on the same schedule as the rest of the sections. In the table below, the assigned laboratory is given for each day of the week. Please note that two experiments (experiments 2 and 5) will cover two weeks. Each of these experiments will have a quantitative portion of the lab that will be graded separately.

| | Scheduled Experiment by lab sections | | | |
|---------|--------------------------------------|---------|-----------|----------|
| Week | Monday | Tuesday | Wednesday | Thursday |
| Jan. 9 | 1 | 1 | 1 | 1 |
| Jan. 16 | Holiday – no lab | 2 | 2 | 2 |
| Jan. 23 | 2 | 2 | 2 | 2 |
| Jan. 30 | 2 | 3 | 3 | 3 |
| Feb. 6 | 3 | 4 | 4 | 4 |
| Feb. 13 | 4 | 5 | 5 | 5 |
| Feb. 20 | 5 | 5 | 5 | 5 |
| Feb. 27 | 5 | 6 | 6 | 6 |
| Mar. 5 | 6 | 7 | 7 | 7 |
| Mar. 12 | 7 | No lab | No lab | No lab |

GENERAL COURSE INFORMATION

How to succeed in this course. In prior years, some students have spent much more time in the laboratory than is intended, apparently largely because they were unprepared to do the laboratory work when they came to the lab, and/or did not think about what they were doing in the lab. You cannot successfully “cookbook” this laboratory and expect to complete all assigned tasks. Here are some tips that will help you succeed!

- Be prepared for lab sessions.
- Plan your work.
- Understand what concepts each laboratory experiment is intended to help you learn.
- Do the “Prelab” exercises well before the day of the laboratory. **REMEMBER THAT THEY NEED TO BE SUBMITTED ON BLACKBOARD PRIOR TO THE START OF YOUR LAB.**
- Understand the calculations you will perform to analyze your data, and how the data you will acquire is used in the calculations.
- Learn how to create Excel spreadsheets, perform calculations, plot graphs, etc.
- If an Excel spread sheet is going to be used in the lab, set it up before you come to lab.
- Think about what you are doing.
- **Work safely.** Think about the safety aspects of your actions.
- Follow the guidelines for writing in your lab notebook.
- Follow the guidelines for writing your lab reports.
- Answer all questions you are supposed to answer.

Safety

- The lab manual contains some brief guidelines. An extensive discussion of contact lenses is on the CHEM 2011 Blackboard site.
- The Graduate Teaching Assistant has absolute authority on matters of safety. If the GTA judges that you cannot work safely in the laboratory, you may be asked to leave the lab. No opportunity to make up a missed lab will be provided if you miss for safety reasons.
- Fashion changes faster than safety guidelines can be rewritten! Think. Layers of clothing are your primary protection against spilled reagents or broken glass. The laboratory is designed to minimize hazards, but safety is ultimately your responsibility.
- Since students in this lab work with aqueous solutions, experience is that wet floors are the major hazard. If you spill water on the floor, clean it up or call it to the attention of the GTA or UTA and warn other students who may be nearby.

Learning Goals. This is the course in the freshman/sophomore coordinated 6-quarter chemistry sequence in which you will learn about the species that exist in aqueous solution, and the equilibria involving these species. You will learn how to calculate and measure pH, solubility, and metal complexation equilibria.

Perform and preserve backups of your computer files. Disasters do happen with computers! It is your responsibility to be sure that you preserve all of the original data acquired in this course and files, such as Excel spread sheets, that you prepare. It is good practice to make a paper copy of spectra and spread sheets before you leave the lab. There is a campus printer available on the ground floor of Olin Hall (just outside of the Biological Sciences office), to which you can print via Ethernet. If you do not have the appropriate software to use DU campus printers, you will need to obtain the software from the Help Desk in Penrose in Driscoll.

Working together. In several labs we will encourage you to share spectrometers, pH meters, burets, etc. For example, we will have 10 spectrometers and 10 pH measurement systems and possibly as many as 20 students in a lab section. For some titrations we *might* suggest that you share burets to save on reagents and save time. However, each student should record all data into their own laboratory notebook and into computer files as appropriate. When data is recorded in computer files, the laboratory notebook should describe the information in the computer file, and record the name of the file. A paper copy of the computer file should be printed and taped into the lab notebook, as well as turned in as part of your lab report.

Regardless of how much you are told to share or work together in acquiring data, your lab report is to be entirely your own work.

Using Laboratory Notebooks

All observations should be recorded in a bound laboratory notebook, or directly into the computer. If data is recorded into the computer, a paper copy (e.g., a print out) must be made before you leave the lab, and this becomes part of the lab notebook.

Spectrometers and pH Measurement Systems

The labs now have new ChemUSB CCD (charge-coupled device) spectrometers manufactured by Ocean Optics Inc., covering both UV and visible spectroscopy ranges. Microelectronics make it possible for the spectrometer to be much smaller than your laptop computer. Indeed, your computer becomes part of the spectrometer system. Don't be misled by the small size - these are research-grade spectrometers, specially configured for use in undergraduate laboratories. Instead of measuring just a number at a wavelength specified in a procedure, you will be able to measure the entire visible spectrum (400-850 nm) and select the spectral information appropriate to the problem you are trying to solve.

The USB in the name of the spectrometer refers to the fact that it will connect to your "laptop" computer via the USB port. Each student will load the software for the spectrometer on a laptop computer to be used throughout the course for both spectra acquisition and analysis. Assistance will be given during the first lab period. With this software you will operate the spectrometer, acquire data into your computer, and perform all necessary manipulations of the spectra. Each student should become familiar with the features of this software in order to optimize its use.

The pH meters have been replaced by a pH measurement system that also uses your laptop computer. Instead of writing down readings from the pH meter in your lab notebook, you will record the pH directly into your computer, using software that will plot the titration curve as you record the data. The system is made by a company called Vernier, the interface box is called LabPro and the software is called LoggerPro.

MISSED LAB POLICY

If illness or a university-sponsored activity causes you to miss a lab, as early as possible seek to schedule a time that you can make it up during another regularly-scheduled lab (there are 8 each week). This will be very difficult this quarter since all labs are full. Except by special arrangement with the Graduate Teaching Assistant, reagents and apparatus will be available only during the week in which the lab is scheduled.

CELLULAR PHONE, PAGER AND LAPTOP POLICY. I respect the need for each individual to stay in contact with family and friends. The use of cellular phones and pagers, however, is disrupting to

the learning environment. Thus, I request that the ringers of all cellular phones and pagers be muted during class. If an emergency arises, and you need to make a call on your phone, I request that you quietly leave the room and conduct your conversation out in the hallway. Laptops can be quite disrupting in class; therefore, **ONLY** laptops used for taking notes will be allowed. If you use your laptop, I might request that a copy of your notes be emailed to me at the end of class.

LECTURE AND TESTING ACCOMODATIONS. I will make every effort to accommodate students diagnosed with a learning disability. I will do this in complete confidence. I do, however, request that any student requiring these accommodations inform me the first week of class. For further information, please see the University Disability Services' website at <http://www.du.edu/disability/dsp/index.html>.

ACADEMIC DISHONESTY. While I advocate collaborative learning and teamwork, I also firmly believe that each individual should maintain the highest ethical standards in all of life's endeavors. As such, I support and will strictly enforce the Honor Code of the University of Denver. For your reference, I have included the link to the Honor Code Statement at <http://www.du.edu/ccs/honorcode.html>.

DEADLINES

Prelab exercises must be completed **BEFORE** you come to the laboratory [note: the prelab for experiment 1 will have a grace period as students get familiar with the Blackboard submission process]. These exercise **MUST BE SUBMITTED ONLINE TO THE BLACKBOARD SITE**. Part of these exercises will be the viewing of specific video clips. You may be asked to answer a simple question for you Prelab to verify that you have viewed the video. ***You will not be given credit for late Prelab exercises.*** It is important that you write up your lab reports while information is fresh in your mind. Lab reports are due at the beginning of the lab period one week after you performed the lab. The GTA's will grade and return your lab reports at least 24 hours before your next lab report is due. This will give you time to make any last minutes corrections based on feedback from the GTA's.

Two experiments (experiments 2 and 5) will involve giving an "unknown" solution. You will be required to that will to analyze and report the value as part of your lab report. A separate portion of your grade will be based on the accuracy and precision of your measurement.

A 4-POINT PER DAY (weekends included) deduction will be applied to all late lab reports.

COURSE GRADING

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|---------------------------------|-----------|------------------|
| Lab notebooks/online activities | | = 16 pts |
| prelabs | 7 x 2 pt | = 14 pts |
| lab reports/activities | 7 x 20pt | = 140 pts |
| unknown analyses | 2 x 15 pt | = 30 pts |
| <hr/> | | |
| total possible points | | = 200 pts |