Syllabus for Chemistry CHEM:3110
Analytical Chemistry I ©

Fall 2018
J. Leddy W358 PBB
LeddyInstruction or chem-leddyinstruction@uiowa.edu

1 Course Objectives

Important to researchers in chemistry-allied fields is the behavior of chemical species at equilibrium. Chemical equilibria captures chemical intuition quantitatively to calculation of concentrations. This course provides the skills needed to appreciate and parameterize equilibrium behavior. All equilibrium problems can be solved using a few basic ideas:

- Equilibrium reactions
- Equilibrium constants, sometimes as redox expressions
- Analytic concentration expressions - mass balances (conservation of mass)
- Charge balance (conservation of charge)

The course objective is to learn to apply equilibrium constraints to a range of chemically interesting systems. Various methods for visualizing information about solutions and titrations are presented. Electrochemical systems are included in these parameterizations through the Nernst equation. Various electrochemical methods (e.g., potentiometry, voltammetry, and ion selective electrodes) are presented. Appropriately parameterized, the chemical composition of any solution at equilibrium succumbs to analysis by these protocols.

At the end of the semester, students will have the tools to appreciate the equilibrium behavior of species in the solution quantitatively.

“SEE THE BEAKER.”

Laptops and tablets are used occasionally in class. Notice is made on ICON and the preceding lecture.

2 Prerequisite Skills

Background necessary for success in this course includes:
- freshman chemistry
- a little chemical intuition
- envisioning the problem (mental movie making)
- expression of problems in algebraic terms
- algebra or algebra solution software
- spreadsheet skills

★ Most important is thinking.
Love of puzzles is useful.

3 Course Outline

1. Introduction (Chapters 0, 1 (especially p. 8 to 20, and Table 1-1, 2, 3), Chapter 3, Sections 4.7, 5.3 and 5.4, and Appendices A, D, and E)
2. Chemical Equilibria - Part I
   (a) Fundamentals (Chapters 6, 8 (except 8.4 and 8.5), 9.1 to 9.4)
   (b) Systematic Treatment of Equilibrium (Sections 8.4 and 8.5 - THE most important part of the book)
   (c) Acids and Bases (Chapters 10, 7, 11, 13)
3. Electroanalytical Chemistry
   (a) Fundamentals (Fun with the Nernst Equation) (Chapter 14)
   (b) Potentiometry (Chapter 15)
   (c) Redox Titrations (Chapter 16)
   (d) Electroanalytical Techniques (Chapter 17)
4. Chemical Equilibria - Part II
   (a) Complexation (Chapter 12)
   (b) Gravimetry (Chapter 27)
   (c) Precipitation Titrations (Chapter 7.4)

4 Course Mechanics

Class Meetings: 10:30 to 11:20 am MWF in 106 Gilmore

Exam Meetings: Two exams are at 6:30 p.m. on Wednesday at location to be announced. The third exam is during the final exam slot. Dates are listed below.

Discussions: The three discussion sections are:

- M 17:30 - 18:20 E203 CB
- T 8:30 - 9:20 E215 CB
- W 14:30 - 15:20 E215 CB

Office Hours - Leddy: Leddy’s Office hours are Wednesdays 13:00 to 14:30 and 11:20 to 11:30, Monday 11:20 to 11:50, and Friday 10:00 to 10:20 and 11:20 to 11:50. Except immediately after class, office hours are in Leddy’s office, W358 PBB. Times immediately after class allow an opportunity to address quick questions in Gilmore 106; if more time is needed, we will move to Leddy’s office. Any additional times and last minute changes will be posted on ICON Announcements. Please refrain from just stopping by Leddy’s office; requests for appointments may be made at chem-leddyinstruction@uiowa.edu. Please use chem-leddyinstruction@uiowa.edu for class relevant communications.
TAs and Office Hours: There are two TAs. Office hours are in E208 CB.

Daniel Parr
daniel-parr@uiowa.edu
Office Hours M, T 16:30 to 17:30

Sajeewani Kumarage
sajeewani-kumarage@uiowa.edu
Office Hours M 8:30 to 9:30; Th 16:30 to 17:30

Homework: Homework is critical to success in class and on exams. You may work together, but do not copy. There are 5 homework assignments. On due dates, please submit homework through ICON under Assignments before the start of class. For questions about homework, contact the TAs or Leddy; for grading of homeworks, please contact the TAs first; for exams, contact Leddy. More details about homework submission will be available on ICON.

Text: Quantitative Chemical Analysis, Daniel C. Harris, 9th Edition, W. H. Freeman and Company, 2016 (ISBN13: 978-1464135385, ISBN10: 146413538X) There are formats other than hardback. This book is available in earlier editions; editions back at least to 6th edition will be appropriate. (This text is sometimes used in other classes at the University, so consider before purchasing a one semester rental of the electronic version.) There will also be occasional handouts posted on ICON.

Laptop or Tablet: When advised, please bring a laptop or tablet to use in class.

Software: Please install a spreadsheet and perhaps One Note on your device. One Note and Excel are available in Office, free to students https://its.uiowa.edu/campus-software-program/software-list/student. The following are not required but may prove helpful in addressing algebra complexities.

o In Windows 10 and Office 365, there are some nice methods for solving equations in One Note (https://support.office.com/en-us/article/Convert-and-solve-math-equations-in-OneNote-for-Windows-10-1b37bb8d-eccd1-40d7-8d0f-5e6e46547441)

o Mathematica and MatLab are available free through Virtual Desktop. (https://its.uiowa.edu/campus-software-program/software-list/student) The input GUI for MatLab and Mathematica takes a little practice, but both can solve higher order algebra problems.

o Wolfram Widgets (http://www.wolframalpha.com/widgets/) such as polynomials and simultaneous linear equations may be useful.

o If you have access to Scientific Word, Scientific Workplace, or Scientific Notebook (MacKichan Software), it contains MuPad. The GUI is fairly easy.

Links: Various links and content are available on ICON. One content module contains parts of the book, Chemical Equilibria by A. J. Bard, which clearly presents methods for solving equilibrium problems, a major objective for the course.

ICON WebPage: There is a class web site on ICON. This includes grades, syllabus, homework assignments, answer keys, the problems to be covered in upcoming lectures, handouts, useful links, example old exams, and messages to the class. Please check for homework addenda and updates that may contain clarifying information. Most information can be found under Modules tab. The calendar is also updated on ICON. ICON is where you submit homework under Assignments. You can access ICON at http://icon.uiowa.edu using HawkID and HawkID password. All material on the ICON site is copyrighted. Please do not post these materials outside the ICON system.

5 Grading

Graded Problem Sets: There will be 5 graded problem sets. The problem sets will have two parts, a brief online Notions Quiz for review of major ideas and the main HW sets. Each problem set is worth 100 points, where 5 points is for the Notions Quiz and 95 points is for the main HW set. The Notions Quiz is taken on ICON and can be repeated as often as needed until the due date and time, which is one week before the corresponding HW set. The HW sets are submitted through Assignments on ICON. You may work in groups on these assignments, however, you may not copy from one another. Many equilibrium constants and reduction potentials that you will need are found in the tables at the back of the text. The HW set due dates are below. All assignments are due at the start of class and will be submitted through ICON. The HW will be downloaded in an Excel spreadsheet. HW answers will be entered into the spreadsheet, the file saved with a specified name, and then the renamed Excel sheet is uploaded to ICON. More details will be follow in a separate attachment. The only allowed formats for submission are xls and xlsx. If the HW material is badly formatted or illegible, zero points will be awarded. Be kind to those who grade. Late assignments are not accepted. Mastery of HW material will be advantageous on the exams.
Quizzes and Exams: One quiz will be given near the start of the semester. This covers the introductory lectures and the material listed above as Introduction (Chapters 0, 1 (especially p. 8 to 20, and Table 1-1, 2, 3), Chapter 3, Sections 4.7, 5.3 and 5.4, and Appendices A, D, and E). (If you have an earlier edition of the text, some section numbers may be different. See ICON for corresponding content in older editions.) This is a review of material intended to refresh everyone’s memory about important concepts in freshman chemistry.

The exams will be two during the regular semester and the third during the final exam period. Exams I and II begin at 6:30 p.m. in TBA. About three hours will be needed for these exams. Sufficient time is allowed so there is time to think. The final is restricted to two hours but is open book. Make-up exams will be oral exams. Dates for exams are listed below.

During Exams: Please leave all books, bags, and notes at the front of the room and take only specified materials to your seat.

Grades: Historically, the average grade for this class has between a C+ and B, depending on class performance. The numerical grade this semester is calculated as quiz (5%), 5 problem sets (5×7%=35%), and 3 exams (3×20%=60%) or for each quiz, problem set, exam and project graded on a 100 point scale:

\[
\text{Grade} = \text{quiz} \times 0.05 + \frac{\text{sum problem set}}{5} \times 0.35 + \frac{\text{sum exams}}{3} \times 0.60
\]

Opportunities for bonus and extra credit points will occasionally be available within HWs and exams. These points will be added to the score for the assignment.

The letter grade is assigned according to a normal distribution. In a recent class, the average total numerical grade was 75.9 \pm 19.2. The B range of grades was \( \approx 75.9 \pm 9.6 \). Grades greater than one half standard deviation above the mean were A’s, and grades below one half standard deviation were C’s or lower. Note that this information is provided only as an estimate of what the grades might be for this class. Final grade assignments will depend on class performance.

Grades are recorded on ICON and are calculated as below. To keep track of your numerical grade, enter the points received on each assignment, and multiply by the indicated factor. For each assignment, the grade is based on 100 points, exclusive of bonus and extra credit points. (With bonus and extra credit, scores >100 are possible, although rare.) You can also access your grades on the ICON webpage.
<table>
<thead>
<tr>
<th>Date</th>
<th>Due</th>
<th>Your Grade</th>
<th>× Percent of Final Grade =</th>
<th>Points</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 August 2018, Wed, 10:30 a.m.</td>
<td>Quiz</td>
<td></td>
<td>× 0.05 =</td>
<td></td>
<td>/5</td>
</tr>
<tr>
<td>12 September, Wed., 10:30 a.m.</td>
<td>Homework #1</td>
<td>× 0.07 =</td>
<td>/12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 September, Wed., 10:30 a.m.</td>
<td>Homework #2</td>
<td>× 0.07 =</td>
<td>/19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 October, Wed., 6:30 - 10:30 p.m</td>
<td>Exam I</td>
<td>× 0.20 =</td>
<td>/39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 October, Wed., 10:30 a.m.</td>
<td>Homework #3</td>
<td>× 0.07 =</td>
<td>/46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 November, Wed., 10:30 a.m.</td>
<td>Homework #4</td>
<td>× 0.07 =</td>
<td>/53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 November, Wed., 6:30 - 10:30 p.m</td>
<td>Exam II</td>
<td>× 0.20 =</td>
<td>/73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 December, Wed., 10:30 a.m.</td>
<td>Homework #5</td>
<td>× 0.07 =</td>
<td>/80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 December, Mon., 8:00 - 10:00 p.m.</td>
<td>Exam III(final)</td>
<td>× 0.20 =</td>
<td>/100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Points (100 Maximum)

\( a \) no class Fri. 5 Oct.; \( b \) no class Fri. 16 Nov.; \( c \) Classes close Fri. 7 Dec;
\( d \) final focuses on electrochem. and is open book, open notes
Note, each Notion Quiz is due one week before the HW is due.
That is, Notion Quizzes are due: 5 Sept., 19 Sept., 10 Oct., 1 Nov (not Halloween), 28 Nov.
6 Manners and Administrative Details

**Computer Access:** All problem sets will be submitted in the spreadsheet template. We will also develop some spreadsheets that will require a laptop or tablet in class. Please bring your device to class when advised and ensure that Excel is installed. Excel is available in the Office Suite that is available free to all students through https://its.uiowa.edu/campus-software-program/software-list/student. If you are not familiar with spreadsheets (e.g., Excel), several guides are listed on the class ICON site. One Note may be useful.

**Attendance:** Except for exams and the final, attendance is neither taken nor required.

**Cell Phones, Pagers, and Other Audible Devices:** Please turn off all audible alarms during class.

**Cheating:** Cheating is not tolerated in this class. If you are found to be cheating, I will pursue the maximum possible penalties for cheating. If you have any questions as to what constitutes cheating, please either see me or see http://clas.uiowa.edu/students/handbook for further details.

**Harassment** Harassment will not be tolerated. University policy on sexual harassment is found at http://www.sexualharassment.uiowa.edu/.

**Special Requirements for Students with Disabilities:** Please contact me *immediately* if you have a disability that may require some modification of seating, testing or other class requirements so that appropriate arrangements may be made.

**Chemistry Department Contact Information:** Students in need of additional information may contact staff in the Chemistry Center E225 CB (335-1341) during normal business hours.

**Additional Constraints from the College of Liberal Arts:** This course is given by the College of Liberal Arts (CLAS). Class policies such as requirements, grading, and sanctions for academic dishonesty are governed by CLAS. Students wishing to add or drop this course after the official deadline must receive the approval of the CLAS Dean. Information on cross enrollments is at: http://www.uiowa.edu/~provost/deos/crossenroll.doc.

**CLAS Policy Statement:** CLAS Policy information is summarized at http://clas.uiowa.edu/faculty/teaching-policies-resources-syllabus-insert and listed in the next section.
7 CLAS Required Insert

**Administrative Home:** The College of Liberal Arts and Sciences (CLAS) is the administrative home of this course and governs its add/drop deadlines, the second-grade-only option, and other policies. These policies vary by college ([https://clas.uiowa.edu/students/handbook](https://clas.uiowa.edu/students/handbook)).

**Electronic Communication:** Students are responsible for official correspondences sent to their UI email address (uiowa.edu) and must use this address for all communication within UI (Operations Manual, III.15.2).

**Accommodations for Disabilities:** UI is committed to an educational experience that is accessible to all students. A student may request academic accommodations for a disability (such as mental health, attention, learning, vision, and physical or health-related condition) by registering with Student Disability Services (SDS). The student should then discuss accommodations with the course instructor ([https://sds.studentlife.uiowa.edu/](https://sds.studentlife.uiowa.edu/)).

**Nondiscrimination in the Classroom:** UI is committed to making the classroom a respectful and inclusive space for all people irrespective of their gender, sexual, racial, religious or other identities. Toward this goal, students are invited to optionally share their preferred names and pronouns with their instructors and classmates. The University of Iowa prohibits discrimination and harassment against individuals on the basis of race, class, gender, sexual orientation, national origin, and other identity categories set forth in the University’s Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity at diversity@uiowa.edu or diversity.uiowa.edu.

**Academic Integrity:** All undergraduates enrolled in courses offered by CLAS have, in essence, agreed to the College’s Code of Academic Honesty. Misconduct is reported to the College, resulting in suspension or other sanctions, with sanctions communicated with the student through the UI email address.

**CLAS Final Examination Policies:** The final exam schedule for each semester is announced around the fifth week of classes; students are responsible for knowing the date, time, and place of a final exam. Students should not make travel plans until knowing this final exam information. No exams of any kind are allowed the week before finals. ([https://clas.uiowa.edu/faculty/teaching-policies-resources-examination-policies/](https://clas.uiowa.edu/faculty/teaching-policies-resources-examination-policies/))

**Making a Complaint:** Students with a complaint should first visit with the instructor or course supervisor and then with the departmental executive officer (DEO), also known as the Chair. Students may then bring the concern to CLAS ([https://clas.uiowa.edu/students/handbook/student-rights-responsibilities](https://clas.uiowa.edu/students/handbook/student-rights-responsibilities)).

**Understanding Sexual Harassment:** Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community must uphold the UI mission and contribute to a safe environment that enhances learning. Incidents of sexual harassment must be reported immediately. For assistance, definitions, and the full University policy, see [https://osmrc.uiowa.edu/](https://osmrc.uiowa.edu/).

**Reactions to Severe Weather:** In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Department of Public Safety website. In the event of adverse conditions, check ICON Announcements for input about whether class will meet.)