1 Course Objectives

Every good chemist has a sense of solution equilibria and the ability to calculate solution concentrations given the appropriate equilibrium constants. This course is intended to provide the skills needed to appreciate and parameterize solution behavior. All equilibrium problems can be solved using a few basic ideas:

- Equilibrium reactions and equilibrium constant and redox expressions
- Analytic concentration expressions - mass balances (conservation of mass)
- Charge balance (conservation of charge)

The objective of the course is to learn to apply these equilibrium constraints to a range of systems of interest in chemistry. Various methods for visualizing information about solutions and titrations will be presented. Electrochemical systems are included in these parameterizations through introduction of the Nernst equation. Various electrochemical methods, which includes potentiometry, voltammetry, and ion selective electrodes will be presented. The chemical composition of any solution at equilibrium should succumb to analysis by these protocols.

At the end of the semester, students will be able to appreciate quantitatively the equilibrium behavior of species in the solution and with the solution.

“SEE THE BEAKER.”

This semester, we will experiment with building modeling skills using laptops and tablets. Please bring your device to each class.

2 Prerequisite Skills

The background necessary for successful completion of 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. A 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.

Office Hours - Leddy: Leddy’s Office hours are Wednesdays 9:30 to 10:25 and 11:20 to 12:50 and Monday and Friday, 11:20 to 11:40. 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 time 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 this email address for class relevant communications.
TAs: There are two TAs and three discussion sections for this class.

<table>
<thead>
<tr>
<th>Email</th>
<th>Office Hours</th>
<th>Discussion Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiranjeewa Lansakara</td>
<td>M 14:30 - 15:30</td>
<td>M 17:30 - 18:20 E215 CB</td>
</tr>
<tr>
<td>Maosong Ye</td>
<td>T 13:30 - 14:30</td>
<td>W 14:30 - 15:20 E215 CB</td>
</tr>
</tbody>
</table>

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

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) In addition to the text, there will be occasional handouts posted on ICON.

Laptop or Tablet: Some class activities will require a laptop or tablet. Please bring your device to class.

Software: Please install One Note and a spreadsheet such as Excel on your device. One Note and Excel are both available in Office, which is available free to all students at https://its.uiowa.edu/campus-software-program/software-list/student.

The following are not required but may prove helpful in addressing algebra complexities. There is a Mathematics add-in for One Note and Word that may be available and perhaps useful (for 2013, https://www.microsoft.com/en-us/download/details.aspx?id=36777; if 2016, this may help for addin in Word https://www.youtube.com/watch?v=KMEMsNL0zjs).

Also available free to UI students through Virtual Desktop are Mathematica and MatLab. The Citrix Receiver must be downloaded first, but this is also downloaded through https://virtualdesktop.uiowa.edu, as described at https://its.uiowa.edu/support/article/102185. The input GUI for MatLab and Mathematica takes a little practice, but both can solve higher order algebra problems. You may want to install Mathematica or similar symbolic manipulator for use later in the semester.

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

Online Resources: The textbook publisher W.H. Freeman provides some online resources at http://www.macmillanlearning.com/Catalog/student-resources/qca9e#.

The quizzes may provide some useful review for each chapter. The Freeman quizzes are not part of the grade.

Reserve: Nothing is on library reserve but 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. You may work in groups on these assignments, however, you may not copy from one another. Some assignments will be carried out more expeditiously in a spreadsheet. Many constants you will need can be found in the tables at the back of the text. The problem set due dates are below. All assignments are due at the start of class and will be submitted through ICON. Late assignments are not...
accepted.
On the problem sets, more challenging questions will be marked. Mastery of this 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.) 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.

All 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.

Historically, the average grade for this class has been 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:

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

The letter grade is assigned according to a normal distribution. In a recent class, the average total numerical grade was 68.3 ± 20.2. This covered the B range of grades. Grades greater than one standard deviation above the mean were A’s, and grades below one standard deviation were C’s or lower. Note that this information is provided as only 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. Maximum points in this scheme is 100. You can also access your grades on the ICON webpage.

<table>
<thead>
<tr>
<th>Date</th>
<th>Due</th>
<th>Your Grade × Percent of Final Grade =</th>
<th>Points</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 September, Fri, 10:30 a.m.</td>
<td>Quiz</td>
<td>× 0.05 =</td>
<td></td>
<td>/5</td>
</tr>
<tr>
<td>12 September, Mon., 10:30 a.m.</td>
<td>Homework #1</td>
<td>× 0.07 =</td>
<td></td>
<td>/12</td>
</tr>
<tr>
<td>28 September, Wed., 10:30 a.m.</td>
<td>Homework #2</td>
<td>× 0.07 =</td>
<td></td>
<td>/19</td>
</tr>
<tr>
<td>5 October*, Wed., 6:30 - 10:30 p.m</td>
<td>Exam I</td>
<td>× 0.20 =</td>
<td></td>
<td>/39</td>
</tr>
<tr>
<td>19 October, Wed., 10:30 a.m.</td>
<td>Homework #3</td>
<td>× 0.07 =</td>
<td></td>
<td>/46</td>
</tr>
<tr>
<td>9 November, Wed., 10:30 a.m.</td>
<td>Homework #4</td>
<td>× 0.07 =</td>
<td></td>
<td>/53</td>
</tr>
<tr>
<td>16 November*, Wed., 6:30 - 10:30 p.m</td>
<td>Exam II</td>
<td>× 0.20 =</td>
<td></td>
<td>/73</td>
</tr>
<tr>
<td>7 December, Wed., 10:30 a.m.</td>
<td>Homework #5</td>
<td>× 0.07 =</td>
<td></td>
<td>/80</td>
</tr>
<tr>
<td>TBA*</td>
<td>Exam III(final)</td>
<td>× 0.20 =</td>
<td></td>
<td>/100</td>
</tr>
</tbody>
</table>

Total Points (100 Maximum)

\[a\] no class Fri. 7 Oct.; \[b\] no class Fri. 18 Oct.; \[c\] Classes close Fri. 12 Dec;
\[d\] final will be set in a few weeks; final focuses on electrochem.
6 Manners and Administrative Details

**Computer Access:** Most problem sets will best be done using a spreadsheet. This semester we will be trying some alternative methods that will require a laptop or tablet in class. Please bring your device to every class and ensure that OneNote and Excel are installed. Both are 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), best to get started learning. Additional programs may be used in the class to handle algebra.

**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 is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Academic Policies Handbook at http://clas.uiowa.edu/students/handbook.

Electronic Communication: University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondences (Operations Manual, III.15.2, k.11).

Accommodations for Disabilities: A student seeking academic accommodations should first register with Student Disability Services and then meet with the course instructor privately in the instructor’s office to make particular arrangements. See www.uiowa.edu/~sds/ for more information.

Academic Honesty: All CLAS students or students taking classes offered by CLAS have, in essence, agreed to the College’s Code of Academic Honesty: “I pledge to do my own academic work and to excel to the best of my abilities, upholding the IOWA Challenge. I promise not to lie about my academic work, to cheat, or to steal the words or ideas of others; nor will I help fellow students to violate the Code of Academic Honesty.” Any student committing academic misconduct is reported to the College and placed on disciplinary probation or may be suspended or expelled (CLAS Academic Policies Handbook).

CLAS Final Examination Policies: The final examination schedule for each class is announced by the Registrar generally by the fifth week of classes. Final exams are offered only during the official final examination period. No exams of any kind are allowed during the last week of classes. All students should plan on being at the UI through the final examination period. Once the Registrar has announced the date, time, and location of each final exam, the complete schedule will be published on the Registrar’s web site and will be shared with instructors and students. It is the student’s responsibility to know the date, time, and place of a final exam.

Making a Suggestion or a Complaint: Students with a suggestion or complaint should first visit with the instructor (and the course supervisor), and then with the departmental DEO. Complaints must be made within six months of the incident (CLAS Academic Policies Handbook).

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 have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment for assistance, definitions, and the full University policy.

Reacting Safely 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.