# Analysis of Equilibrium Systems
# CHEM 2011-1
# Winter Quarter, 2008

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| **Instructor** | Dr. Keith Miller |
| **Office:** | SGM 105 |
| **Contact info:** | phone: 303.871.7721; email: keith.miller@du.edu |
| **Class Time:** | MWThF, 9:00 – 9:50AM |
| **Class Location:** | Olin 105 |
| **Office Hours:** | MWTh, 11:00AM – 12:00PM; "virtual hours" online, TBA; other times by arrangement |

## REQUIRE COURSE ITEMS

**Textbook:** *Exploring Chemical Analysis*, 3rd ed., by Daniel C. Harris ***OR*** *Quantitative Chemical Analysis*, 7th ed., by Daniel C. Harris (both available at the DU Bookstore). I recommend that Chemistry and Biochemistry majors purchase the latter text since I will use this in Instrumental Analysis.

**Calculator:** An inexpensive calculator is required. It should have the capabilities for square roots, logarithms, and exponential (scientific) notation operations. You are responsible for understanding how to perform each of the operations on your calculator. **Remember to bring your calculator (or laptop) with you to every class.**

**Clickers:** We will use the same H-ITT clicker system used in Organic Chemistry. **Please inform me immediately if you do not have your clickers.**

## SUPPLEMENTAL COURSE ITEMS

**Textbook:** *Chemistry*, 3rd or 4th eds., by Martin S. Silberberg (textbook used for CHEM 1010).

**Solutions Manual:** *Solutions Manual for Exploring Chemical Analysis*, 3rd ed., by Daniel C. Harris ***OR*** *Solutions Manual of Quantitative Chemical Analysis*, 7th ed., by Daniel C. Harris (both available at the DU Bookstore).

## COURSE DESCRIPTION

Analysis of Equilibrium Systems is the fifth course in the six quarter freshman/sophomore chemistry sequence. The course is an introduction to chemical equilibria and kinetics. Chemical equilibria will focus on aqueous systems, starting first with simple systems. Discussions will progress to advanced applications of complex equilibria, including examples from biological and environmental systems.

## LECTURE

The format of class meetings will follow traditional lecture format on MWF. I will summarize new material and present illustrations and examples. In lecture, I WILL NOT identify and describe every detail you will read in the text and any supplemental materials. I will, however, emphasize the important topics covered in the reading as well as problem solving strategies when appropriate. You should stop me at any time if you have questions about the material being covered.

The Thursday (Th) class meetings will be devoted to quizzes, problem solving, and group activities. No new lecture material will be covered on these days. However, material from the lecture will be

explored in greater detail. A short quiz may be administered at each meeting. We will work on specific "challenge problems" in small groups, go over spreadsheet applications, and after the hour exams, complete exam keys. If time permits, we will go over any questions you have on the material covered in lecture or homework problems.

**CLICKERS**

It is my goal that all lectures be conducted in an active learning environment. Therefore, we will use the H-ITT clicker system that most of you just used in Organic Chemistry. I will stop periodically and ask you to apply what we have just covered. At times, I will ask you to work with other students to solve problems or answer questions. I encourage you to make the most of these interactions. Experience has shown me that other students often succeed in describing chemistry concepts where professors and instructors fail.

**READING**

You are expected to complete the assigned reading prior to the class lecture. After lecture, you should reread the assigned text. In addition, you are also encouraged to attempt the "Ask Yourself" exercises throughout the text while you are completing your assigned reading. I recommend that you understand the material and how to solve the sample problems before proceeding to the next section. At the end of each chapter, a summary of important equations and terms is provided that should prove helpful in the preparation for quizzes and exams.

**PROBLEMS**

Problem solving is an important component of all chemistry and most science courses. For most students, successfully solving problems requires practice. In addition to completing the "Ask Yourself" exercises in the text, I strongly suggest that you complete the suggested problems that will be posted. While you are not required to turn the completed problems in for a grade, I highly recommend that you attempt all of them. These problems are typical of those you might encounter on quizzes and exams.

**GRADED EXERCISES**

The suggested problems will not be graded. Challenge problem sets, however, will be assigned during the course that will be graded. These problems are more difficult than the suggested problems, and will require significant effort on your part. You will work together in small groups to complete the problems. The completed exercise will be handed in for a grade.

**NUMERACY**

On the first day of class, a page of sample mathematical calculations will be given you. You should be able to do all of these calculations. You need to be able to do this level of math as a prerequisite for this course. A brief quiz will be given the first FULL week of class during the tutorial session that covers similar material. There will be a requirement that students achieve at least 8 out of a possible 10 points on this test before the end of the third week of the Quarter.

**QUIZZES and EXAMS**

Quizzes will be administered weekly on Thursday or Friday, with the exception of the class meetings following the hour exams. The quizzes will be short (10 – 15 minutes), and will cover material from the preceding 3 – 4 lectures. A significant portion of each quiz will cover material that I have covered in lecture and material that you have seen during group work. The quizzes will be similar in nature to assigned (problem sets) and suggested homework problems. An estimated seven (7)

quizzes will be given throughout the course. Your lowest quiz score will be dropped and only the scores on the remaining quizzes will comprise the "Quiz" portion of your final grade. Three (3) exams will be given during the quarter: two hour exams and a final exam. Exam problems will be similar to the problems given in the weekly quizzes and to those found on the problem sets.

If you will be out of town for a University sanctioned function (e.g., athletic team or music group), you are responsible for making arrangements with Dr. Miller at least one week in advance to take the quiz or an hour exam early. **THERE WILL BE NO MAKE-UP QUIZZES. Only in extremely extenuating circumstances will a make-up hour exam be given. This will require documentation that justifies the need for the make-up (e.g., a letter from Student Health).**

## GRADES

At the end of the quarter, you will be graded according to your performance on cooperative learning activities, clicker responses/participation, quizzes, and examinations. Cooperative learning is encouraged. As such, I will not grade on a curve. Your final grade will be determined by the percentages with the following components:

| Component | Default |
|---|---|
| Group Work/Graded Exercises | 10% |
| Clickers/Participation | 10% |
| Quizzes | 20% |
| Hour exams | 40% |
| Final exam | 20% |
| Total | 100% |

## CELLULAR PHONE AND PAGER 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.

## 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. I have included the links for the Honor Code Statement and Honor Code Procedures for Students below. For further information, please see the Office of Citizenship & Community Standards' website at http://www.du.edu/honorcode/statement.htm for the Honor Code Statement and at http://www.du.edu/honorcode/studentprocedure.htm for the Honor Code Procedures for Students.

**TENTATIVE SCHEDULE**

| Meeting | Date | Topic | Reading |
|---|---|---|---|
| 1 | Jan 2 | Introduction; Units; Solutions | ECA: 13 – 22<br>QCA: 9 – 14 |
| 2 | Jan 3 | Installation of software for labs (Monday/Tuesday sections have priority -- meet in lecture room) | |
| 3 | Jan 4 | Solutions cont.; Preparing solutions | ECA: 22 – 25<br>QCA: 14 – 15 |
| 4 | Jan 7 | Equilibrium | ECA: 25 – 29<br>QCA: 97 – 100 |
| 5 | Jan 9 | Equilibrium cont.; error | ECA: 55 – 58, 71 – 79<br>QCA: 42 – 44, 53 – 62, 65 |
| 6 | Jan 10 | Volumetric analysis<br>(a.k.a. - Titrations!) | ECA: 109 – 113<br>QCA: 121 – 125 |
| 7 | Jan 11 | Numeracy Quiz, Group Work | |
| 8 | Jan 14 | Acids and bases | ECA: 153 – 156<br>QCA: 105 – 108 |
| 9 | Jan 16 | Acids and bases cont. | ECA:156 – 161<br>QCA:108 – 112,159 – 160 |
| 10 | Jan 17 | Weak acid/ weak base Equilibria | ECA: 162 – 170<br>QCA: 161 – 167 |
| 11 | Jan 18 | Weak acid / weak base Equilibria cont | ECA: 162 – 170<br>QCA: 161 – 167 |
| -- | Jan 21 | MLK Holiday – DU Holiday – No Class | |
| 12 | **Jan 23** | **Hour Exam I** | |
| 13 | Jan 24 | Exam Key; group work | |
| 14 | Jan 25 | Buffers | ECA: 175 – 180<br>QCA: 167 – 171 |
| 15 | Jan 28 | Preparing buffers | ECA: 181 – 185<br>QCA: 172 – 176 |
| 16 | Jan 30 | Strong acid/base titrations | ECA: 193 – 206<br>QCA: 199 – 212 |
| 17 | Jan 31 | Group work | |
| 18 | Feb 1 | Weak acid/base titrations | ECA: 193 – 206<br>QCA: 199 – 212 |
| 19 | Feb 4 | Weak acid/base titrations, cont.; endpoints | ECA: 193 – 206<br>QCA: 199 – 206 |
| 20 | Feb 6 | Indicators | ECA: 185 – 189<br>QCA: 212 – 216 |
| 21 | Feb 7 | Group Work | |

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| 22 | Feb 8 | Polyprotic acids and bases | ECA: 219 – 228<br>QCA: 181 – 189 |
| 23 | Feb 11 | Principle species; Titrations of polyprotic systems | ECA: 228 – 237<br>QCA:190 -192, 206 - 208 |
| 24 | **Feb 13** | **Hour Exam II** | |
| 25 | Feb 14 | Exam II key; group work | |
| 26 | Feb 15 | Solubility product | ECA: 117 – 122<br>QCA: 100 –104, 131 - 132 |
| 27 | Feb 18 | Ionic strength; Activity coefficients | ECA: 243 – 251<br>QCA: 141 – 147 |
| 28 | Feb 20 | Systematic treatment; Fractional composition | ECA: 251 – 259<br>QCA: 147 – 154 |
| 29 | Feb 21 | Group Work | |
| 30 | Feb 22 | EDTA titrations | ECA: 265 - 282<br>QCA: 228 – 246 |
| 31 | Feb 25 | Chemical kinetics<br>(reaction rate) | S: 673 - 679 |
| 32 | Feb 27 | Chemical kinetics<br>(rate laws) | S: 679 - 691 |
| 33 | Feb 28 | Group Work | |
| 34 | Feb 29 | Chemical kinetics<br>(rate laws continued) | S: 679 - 691 |
| 35 | Mar 3 | Chemical kinetics<br>(temperature/concentration) | S: 692 - 700 |
| 36 | Mar 5 | Chemical kinetics<br>(mechanisms/catalysis) | S: 700 - 712 |
| 37 | Mar 6 | Lab Final (written portion) | |
| 38 | Mar 7 | Chemical kinetics<br>(mechanisms/catalysis continued) | S: 700 - 712 |
| 39 | Mar 10 | Review | |
| 40 | **Mar 14** | **Final – 8:00 to 9:50 AM** | |

ECA – Exploring Chemical Analysis; QCA – Quantitative Chemical Analysis; S – Silberberg, 4th ed.