

CHEMISTRY 271 (CHEM 271)
GENERAL CHEMISTRY AND ENERGETICS
SPRING, 2007: M,W: 9:00-9:50 A.M., CHEMISTRY 1407

Assoc. Prof. Jason D. Kahn, Dept. of Chemistry and Biochemistry, Univ. Maryland, College Park

Office: Chemistry 2500A (Biochemistry, Wing 5 of the Chemistry complex)

Office hours: Weds. 2-3 p.m., Thurs. 1-2 p.m., Chemistry 2500A

Contacting me: **jdkahn@umd.edu** much preferred to 301-405-0058. Please include "CHEM271" at the beginning of your subject line. Please do not drop in to my office or lab, but I will set up appointments outside of office hours if necessary.

Web and email: The course web site is available through Blackboard (<http://elms.umd.edu>).
You should already be subscribed to the e-mail reflector for the course.

Discussion TA: Sarah Sucayan (ssucayan@umd.edu)

Office Hours: Mon. 2-3, Tues. 2-3 Chemistry 2507

Discussion Sections:

2122(12799) Tu.....9:30am-10:20am (CHM 0124) [CHM = Chemical Engineering]

2124(12800) Tu.....11:00am-11:50am (PHY 4220) [PHY = Physics]

2125(12801) Tu.....12:30pm- 1:20pm (PHY 4220)

2142(12802) Th.....9:30am-10:20am (PHY 1219)

2144(12803) Th.....11:00am-11:50am (CHM 0119)

2145(12804) Th.....12:30pm- 1:20pm (CHM 0124)

Course Description

Chemistry 271 is the fourth semester of our integrated introduction to general and organic chemistry. This course covers aspects of chemical thermodynamics and kinetics. Thermodynamics is the study of what is possible and the extent to which it is possible. Kinetics is the study of how rapidly the possible chemical transformations actually occur. The material covered here is required for a fundamental understanding of biochemistry. It will help place your qualitative understanding of chemical reactivity from organic chemistry on a more quantitative basis. Physical chemistry will explore more of the underlying theories for the concepts developed here. The following areas will be emphasized:

- Acid-base reactions and equilibria, buffers
- Thermodynamics: enthalpy, entropy and free energy
- Relationships among thermodynamics and chemical equilibria
- Electrochemistry and oxidation-reduction reactions, and their connection to thermodynamics
- Reaction rates and orders, elementary reactions, activation energy

There are three sections of Chemistry 271, each including different special topics that are extensions of the core material above. This section is the "bio-flavored" one, as I am a biophysical chemist. Time permitting, the special topics we will cover are listed below. I will provide photocopies or web-based material to accompany the lectures on these topics.

- Acid-base: Modulation of protein folding and enzymatic activity and mechanism by pH.
- Thermodynamics: Theory and application of DNA hybridization (duplex formation)
- Redox: Alternative metabolic lifestyles among the single-celled set
- Kinetics: Pharmacokinetics, or blood considered as a beaker

Relationship to Other Sections and Courses

Prerequisites for this course include Chemistry 131, 231, and 241, all of which I hope you have not forgotten. We will use some calculus as well. Some of the early part of this course may be review for you.

The three lecture sections of Chemistry 271 (at 9, 12, and 3) have independent schedules and may cover different material, especially in the extension sections. Exams are independent. We may or may not choose to have some common questions on the final. You are strongly advised to attend the lectures for the section for which you registered. The three sections will have similar curves, probably roughly 1:1:1 A:B:C, plus lower grades as required. Therefore, switching sections should not affect your grade.

The Discussion sections for the class are required. There may be material that is presented in only in Discussion for which you will be responsible on exams. There may be short quizzes given in Discussion, but you will always be notified on Monday if there is to be a quiz that week. You are permitted to attend different discussion times if it okay with Sarah, but as above you are strongly urged to remain with this section of the course.

Almost all of you are concurrently taking the laboratory course, Chemistry 272. We have attempted to coordinate coverage between lab and lecture, but we may not always be successful. Lab lectures will be given by Dr. Bonnie Dixon. Most of you are probably in the Friday, 9 a.m. lab lecture section.

This is the first time this course is being given. Please bear with us as we smooth the rough edges, and feel free to send feedback about how the course could be better organized.

Assignments, Procedures, and Grading

The breakdown for points (500 total) is as follows:

Hour exam 1: 100 points

Hour exam 2: 100 points

Quizzes and homework: 100 points (I anticipate three graded problem sets through Blackboard and two discussion quizzes \times 20 points each.) Thoughtful completion of all assigned work, whether or not it is graded, is strongly correlated with overall success!

Final exam: 200 points

The exams will be difficult. You are not expected to get 90% to get an A. When in real life do we ever really expect to approach perfection? Formal letter grades will not be assigned for individual exams, only at the end of the course. As mentioned above, final grades will be based on a curve with a distribution of about 1:1:1 A:B:C, with some adjustment possible depending on how the class as a whole performs. D's and F's will be given only as needed, but given without hesitation.

If you absolutely must miss an hour exam, you must call me in advance or within 24 hours after the exam, and you must also present a valid University excuse (please secure a note from the Health Services if possible). You can then either take a makeup exam or be assigned a grade based on the remaining exams and homework. If you miss the final or both hour exams, you will receive a failing grade. Cheating will not be tolerated: I expect and enforce adherence to the University's Code of Academic Integrity, found at <http://www.studenthonorcouncil.umd.edu/code.html>. I expect you to write out and sign the University honor pledge on each exam: **"I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination."** Cell phones must be stored out of reach and sight during exams. Finally, though there will not be much scope for plagiarism, as a condition of remaining in the class you are specifically directed to read my own web page on this: <http://www.biochem.umd.edu/biochem/kahn/plagiarism.html>.

Please try to be on time for class. Please make sure that your cell phone does not ring during class.

Textbooks

Required: McMurry, J. and Fay, R.C. (2004). *Chemistry*. 4th edition. Pearson/Prentice Hall, Upper Saddle River, NJ. Text web site: http://wps.prenhall.com/esm_mcmurry_chemistry_4

On reserve in the Chemistry Library: Nash, L.K. (1972). *CHEMOTHERMO: A statistical approach to classical chemical thermodynamics*. Addison-Wesley, Reading, MA.

Any undergraduate biochemistry textbook will be a useful resource for Special Topics I, II, and III.

Photocopies or PDF files of ancillary material will be provided.

Tentative Lecture Outline

Chapters containing relevant sections to be read for background or amplification are specified for each lecture. Try to read ahead. You are not responsible on exams for material covered only in the book unless this is specifically announced. You are, however, responsible for the methods used for any homework questions, whether or not the homework is graded.

I. Chemical Equilibria, especially acid-base

1. Review of chemical equilibrium and equilibrium constants; 13.1-13.5 W, 1/24/07
Lab lecture F, 1/26/07: Error analysis
2. LeChatelier's principle; 13.6-13.10 M, 1/29/07
3. Acid-base reactions and the pH scale; 15.1-15.6 W, 1/31/07
Lab lecture F, 2/2/07: UV-vis spectrophotometry
4. K_a , pK_a , K_w , Lewis acids and bases; 15.7-15.16 M, 2/5/07
5. Henderson-Hasselbach, buffers and titrations; 16.1-16.9 W, 2/7/07
Lab lecture F, 2/9/07: Introduction to buffers
6. Special topic I: Ionizable groups in proteins and enzymes M, 2/12/06
7. Protonation/deprotonation in enzymatic reaction mechanisms W, 2/14/07
Lab lecture F, 2/16/07: Acid-base chemistry of indicators
8. pH and enzymatic activity, review of lectures 1-7 M, 2/19/07

II. Thermodynamics

9. Review of thermochemistry; 8.1-8.12 W, 2/21/07
Lab lecture F, 2/23/07: Practical aspects of equilibrium calculations
10. Statistical basis of entropy; 8.13 and 17.1-17.6 M, 2/26/07
11. Free energy and chemical equilibrium; 17.7-17.11 W, 2/28/07
Lab lecture F, 3/2/07: Overview of potentiometric titrations
12. Special Topic II: DNA hybridization thermodynamics M, 3/5/07
13. DNA hybridization applications W, 3/7/07
Lab lecture F, 3/9/07: Titrations of polyprotic acids and amino acids
14. Exam review M, 3/12/07

→ EXAM I ← Covers through Lecture 13 W, 3/14/07

Lab lecture F, 3/16/07: Lab midterm

→ Spring Break ← No lectures 3/19/07-3/23/07

III. Electrochemistry

15. Galvanic cells and standard reduction potentials; 4.6-4.12, 18.1-18.4 M, 3/26/07

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| 16. The Nernst equation and calculation of equilibrium constants; 18.5-18.10
Lab lecture F, 3/30/07: Redox reactions and titrations | W, 3/28/07 |
| 17. Special Topic III: Redox reactions in biochemistry | M, 4/2/07 |
| 18. Anaerobic biology, electron donors and acceptors powering biology
Lab lecture F, 4/6/07: Back titrations | W, 4/4/07 |
| 19. Review and/or catch up day | M, 4/9/07 |

IV. Chemical Kinetics

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| 20. Reactions rates, reaction order, measurement of rates; 12.1-12.4
Lab lecture F, 4/13/07: Vitamin C: A member of the antioxidant family | W, 4/11/07 |
| 21. Reaction order, differential and integrated rate laws; 12.5-12.7 | M, 4/16/07 |
| 22. Reaction mechanisms, activation energy; 12.9-12.12
Lab lecture F, 4/20/07: Practical aspects of first and second order reactions | W, 4/18/07 |
| 23. Special topic IV: Pharmacokinetics concepts, ADME | M, 4/23/07 |
| 24. Pharmacokinetics: examples
Lab lecture F, 4/27/07: Final review | W, 4/25/07 |
| 25. Exam II review | M, 4/30/07 |

→ EXAM II ← Covers through Lecture 24 **W, 5/2/07**

Lab lecture F, 5/4/07: Lab Final

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| 26. Review and/or catch up day | M, 5/7/07 |
| 26. Final review
Study Day F, 5/11/07 | W, 5/9/07 |

→ COMPREHENSIVE FINAL EXAM ← **Monday, 5/14/06, 10:30 a.m.-12:30 p.m.**