CHEMISTRY 271 (CHEM 271, GENERAL CHEMISTRY AND ENERGETICS), FALL, 2018

Sections 23xx, MW 3:00 pm–3:50 pm, Chemistry 1407, University of Maryland, College Park

Assoc. Prof. Jason D. Kahn, Dept. of Chemistry & Biochemistry

Dr. Kahn:	Chemistry 2500A, in Biochemistry, Wing 5 of the Chemistry complex (Bldg. 091)
Office hours:	Weds 1:30-2:30 p.m.; Thurs. 1:30-2:30 p.m.; or by appointment. I may need to miss or reschedule office hours once in a while, but I will announce this ahead of time.
Contacting me:	jdkahn@umd.edu much preferred to 301-405-0058. There are >180 of you: please include "CHEM271" in your subject line, quote any previous correspondence in your emails, and do not ask questions that are answered in this document. **Do not email me through ELMS!** Please do not drop in to my office or lab, but I make appointments outside of office hours.
TAs:	Alessandra Zimmermann (azimmer2@umd.edu); Alessandra will conduct Discussion Sections. She will hold her office hours between discussion sections, in Chemistry 0128, TuTh 1:30-2:00 and 3:00-3:30 p.m. Discussions begin in the second week of class.

Please see us as early as possible with any questions or concerns: do not wait until an exam looms!

Web and links:	The class web site is provided ELMS at http://myelms.umd.edu. Grades will be posted. My personal site http://www.biochem.umd.edu/kahn/index.html has a repository of exams and resources like Matlab and Excel programs. Notifications to the class go through ELMS or a Coursemail listserv. Change your ELMS settings to receive announcements as they arrive rather than as a digest. Your university email address must work. The Mastering Chemistry web-based homework and e-book site is at www.pearsoncustom.com/md/umd_mastchem/. See directions below. We will not use clickers.

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Discussion Sections (required):
2326   Tu.....12:30pm - 1:20pm (CHM 0128)  CHM = Chemistry Bldg. (091)
2327   Tu......2:00pm - 2:50pm (CHM 0128)  0xxx = Basement
2328   Tu......3:30pm – 4:20pm (CHM 0128)  x1xx = Wing 1
2346   Th.....12:30pm - 1:20pm (CHM 0128)  xx28 = Room CHM 0128
2347   Th......2:00pm - 2:50pm (CHM 0128)  (AZ's office hours between
2348   Th......3:30pm - 4:20pm (CHM 0128)      sections)
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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 will help place your qualitative understanding of chemical reactivity from organic chemistry on a more quantitative basis. It is required for a fundamental understanding of biochemistry. Physical chemistry explores more of the underlying theories for the concepts developed here. The following areas will be emphasized:

- Ideal gas law: where does it comes from?
- Kinetics: Maxwell-Boltzmann distribution, reaction rates and orders, elementary reactions and mechanisms, the steady state approximation, activation energy, catalysis
- Chemical Equilibria: K_{eq}, especially acid-base reactions; pK_a, titrations, buffers.
- Thermodynamics: The statistical basis of the universe. Enthalpy, entropy and free energy, 1st, 2nd, and 3rd laws of thermodynamics, heat capacities
- Relationships among thermodynamics and chemical equilibria: where does K_{eq} come from?
- Electrochemistry and oxidation-reduction reactions, and their connection to thermodynamics. Batteries and electrolytic reactions.

There will also be "bio-flavored" (since I am a biophysical chemist) special topics that are extensions of the core material above. Time permitting, the special topics we will cover are listed below:

- Acid-base: Modulation of protein folding and enzymatic activity and mechanism by pH.
- Thermodynamics: Theory and application of DNA hybridization (duplex formation).
- Redox: Real batteries and electrodes; alternative metabolic lifestyles among prokaryotes.
- Society: Thermodynamics of climate change and possible solutions.

Background Expectations:

- I expect familiarity with Chem 131 and simple organic chemistry like S_N1 and S_N2 reactions.
- You are expected to be able to do algebra. During the class we will use Microsoft Excel and Matlab, which are both downloadable for free from terpware.umd.edu.

Textbook, On-line Homework, and Other Sources

Required: Nivaldo J. Tro (2018). *Chemistry: Structure and Properties*. 2nd edition. Pearson, USA. The bookstore sells a custom reduced-cost softcover Special Edition for 271 consisting of chapters E, 9, 10, 11, and 13-20. It comes bundled with e-book access to the entire text and 36-month MC registration (ISBN 1323882006 // 9781323882009). You can instead buy access to the e-book only, with 6 months of Mastering Chemistry, from the UMD-specific publisher's site at http://www.pearsoncustom.com/md/umd_mastchem/ (this is the least expensive option, ISBN 1323918795 // 9781323918791). You can buy the complete text with MC at the bookstore (ISBN 0135357101 // 9780135357101). You can buy or rent the complete text (ISBN 978-0134293936) at Amazon, but you will need to buy Mastering Chemistry access separately. **I do not recommend other Editions of the text. I do not recommend buying Mastering access from any source other than the bookstore or from Pearson directly, through the UMD site.**

Sections in Tro for background or amplification are specified for each lecture. You are not responsible for material covered only in the book unless this is specifically announced. You are, however, responsible for the methods used for any assigned homework questions.

Supplementary text on reserve in the STEM Library: L.K. Nash (1972). ***CHEMTHERMO: A statistical approach to classical chemical thermodynamics*.** Addison-Wesley, Reading, MA.

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

Lecture Attendance, Notes, and Suggestions for Success

All lecture notes and ancillary files will be posted to ELMS, typically after the lecture. The lecture notes are sometimes quite detailed, as there is material covered that is not in the text. They are also incomplete: I may give more or different examples on the board than in lecture. The PowerPoint is not a substitute for lecture attendance! If I could write a document that encapsulated the lecture experience it would be called a textbook…but if textbooks, Wikipedia, MOOCS, and YouTube could replace professors there would be no need for you and I and the TA to have this quality time together. A day may come when you can self-teach all of this material in an isolated electronic cave and set me loose on an ice floe, but it is not this day.

I recommend that you take notes in lecture, and then soon after the lecture go over or recopy them, combine the notes with the PowerPoint, and use the textbook/web to help with anything you don't understand. Then ask a friend, the TA or myself about anything that is not clear, ideally before the next lecture. There are few things more frustrating than sitting through a lecture that is incomprehensible because you lack the background: don't do this to yourself. You may record lectures, and I will also try to Panopto them, but Panopto often fails.

If I suggest that you work an example, that is a hint about what might be on an exam. Do the assigned problems and sample exams well before the exam, so you will have time to read the answer keys carefully and study the material accordingly. **KEEP UP WITH THE MATERIAL!**

Requirements, Grading, and Academic Honesty Policies:

The breakdown for points (550 points total for the class) is as follows:

Quizzes and homework: 150 points. There will be two discussion quizzes × 20 points each and 60 points for Mastering Chemistry homework. You must also do a brief "Muddy/Clear" ELMS survey after each class by writing one or two anonymous sentences about the class that day. The surveys will be worth a total of 50 points.

Midterm exam 1 (50 min): 100 points

Midterm exam 2 (50 min): 100 points

Final exam (120 min): 200 points

All quizzes and exams are Major Graded Events!

I encourage questions, discussion, and participation in class and discussion section activities, but these do not affect grading. Problems from the book in addition to Mastering Chemistry may be assigned but not graded. Your exam performance is likely to be highly correlated with the effort you put in on problems and practice exams.

Discussion sections are required. There may be material that is presented in only in Discussion for which you will be responsible. The two short required quizzes will be given in Discussion. Dates for quizzes will be confirmed at least a week before each quiz. You can attend different discussion times if it is okay with the TA, but as with lecture (see below) you should remain with this 271 section rather than attending any of the other sections' discussions.

ENGAGED ATTENTION, PARTICIPATION, AND THOUGHTFUL COMPLETION OF ALL ASSIGNED WORK, GRADED OR NOT, IS STRONGLY CORRELATED WITH OVERALL SUCCESS!

Exams will be about 50% relatively easy questions, testing your comprehension of lecture material, and about 50% more difficult questions, testing your ability to apply and extend this basic knowledge. Each exam will explicitly cover mostly the recent part of the course but will inevitably draw on older material. My exams tend to be difficult: they are intended to stretch your thinking, not reward casual effort. Old exams can be found at http://www.biochem.umd.edu/kahn. Exams may require calculators (of any sort that handles logs), and no other aids will be permitted, but formulas and equations will be provided. If you have a disability issue handled through DSS, please let me know as soon as possible so that accommodations can be made. Finally, if we are to take the trouble to grade your work, you should take the trouble to see how you can improve. **All exams and quizzes must be picked up before the end of the semester. I will deduct 4 points for every exam or quiz that is still in my possession at the time of the final exam.**

Your final grade will be based on your performance relative to the class and to my expectations (*i.e.* it's curved, but I draw the lines between grades depending on how the class as a whole performed). Letter grades will not be assigned on the midterm exams but I will give feedback on the curve with each one. You do not need to score 90 % to get an A—when in real life do we ever really expect to approach perfection? I anticipate roughly 30:30:30:10 A:B:C:D, with D's and F's given only as needed but without hesitation. Plus/minus grades will be given. Exam and quiz grades and your totals from Mastering Chemistry will be available on ELMS.

Grade Adjustments: Students often ask whether improvement counts, and someone is often one point below any cutoff. My grading policies takes these issues into account in an objective way as follows: (1) I assign cutoffs (just as a concrete example, the A/B line might be at 430 points and the B/C line at 360). Anyone whose overall point total is above the cutoff receives the higher grade. (2) Anyone whose score is less than 15 points below the cutoff is assessed individually. If his/her final exam score is greater than or equal to the average of the final exam scores of the students scoring at the grade level above the cutoff, the higher grade is awarded. In our example, if the average final exam score among students scoring between 360 and 430 happened to be 126.3, then anyone having a point total between 345-360 and scoring ≥ 127 points on the final would earn a B–. (3) Otherwise, anyone who scores anywhere in the B/C/D range who achieves the average final exam score of the A/B/C group respectively will get a B+/C+/C–. Otherwise, +/- grades are assigned according to cutoffs assigned according to breaks in the curve. Finally, (4) anyone who scores above the median on the final will get at least a C– and pass the class. I have had to make good on this last promise approximately twice in 24 years.

Regrades: If there is clerical error or a mismarked multiple choice question on an exam, just let me or the TA know and we will fix it. If you believe there is a substantive grading error, you may submit the exam to me for regrading, along with a note describing the issue. Do not alter the exam itself in any way. I reserve the right to regrade the entire exam, so it is only worth your while to ask for a regrade if you feel truly underappreciated. I also reserve the right to refuse to regrade any exam written in pencil or multiple colors. My exams are still graded by humans, so there are always a few points that could be argued about, which is a waste of time and effort. Therefore, **only regrade changes of 5 or more points will actually be applied, except for clerical errors.** Regrade requests will be accepted up to one week following the return of the exam.

Missed Exams: If you absolutely must miss a quiz or 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 will then be permitted to take a make-up exam, or, preferably, assigned a grade based on the remaining exams and homework. If you have undocumented absences for the final exam or both hour exams, you will fail the class. All quizzes and exams are Major Graded Events.

Cheating will not be tolerated. The University's Honor Council sets high standards for academic integrity, and I support its efforts. Please note in this regard the University Honor Pledge. The Student Honor Council proposed and the University Senate approved this Pledge: "I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination." You will be asked to write out and sign the pledge statement on all examinations (http://www.shc.umd.edu/SHC/HonorPledgeUse.aspx). Furthermore, I enforce adherence to the University's Code of Academic Integrity http://www.ugst.umd.edu/courserelatedpolicies.html). You are also hereby specifically directed to read my personal statement on plagiarism at http://www.biochem.umd.edu/kahn/plagiarism.html, as a condition of taking this course. Cell phones must be turned off and stored out of reach and sight during exams, and headphones may not be used.

Finally, the campus Senate has approved a variety of detailed policies and procedures covering your rights and responsibilities. These can also be found at http://www.ugst.umd.edu/coursserelatedpolicies.html. Please let me know if you think anything in this document substantively conflicts with University policy.

Please try to be on time for class. **PLEASE MAKE SURE THAT YOUR MOBILE PHONE DOES NOT RING DURING CLASS. PLEASE DO NOT USE A LAPTOP DURING CLASS**: I have found in the past that they are too much of a distraction for you and your neighbors. Finally, I can't realistically stop you from texting, but

YOU CAN'T REALISTICALLY LEARN AND TEXT AT THE SAME TIME: PICK ONE.

Relationship to Other Sections and Courses

Prerequisites for this course include Chemistry 131, 231, and 241, all of which I hope you remember well. In particular, you should be familiar with the idea of chemical bonding and hybridization, bond energies, stoichiometry, functional groups, nucleophiles and electrophiles, and acids and bases. We will use some calculus as well, although you will not need to use it for assignments or exams. You are expected to be able to do algebra easily and quickly. During the class we will use Microsoft Excel and Matlab.

The two lecture sections of Chemistry 271 (this one and the one taught by Dr. Ondov) cover most of the same topics, but they almost certainly will not be in sync. You are strongly advised to attend the lectures for the section for which you are registered. Exams and curves are independent, but the sections will have similar expectations of students, so your section choice should not affect your grade. Many of you are concurrently taking the bioanalytical chemistry laboratory course, Chem 272 or Chem 277, with Dr. Schech or Dr. Blough. We have attempted to coordinate coverage between lab and lecture, but lecture tends to fall behind by the end. Chemistry 272 and 277 are stand-alone courses, and the grading policies and any curves for the all the classes are completely independent. Neither I nor the TA will have any specific knowledge about the lab you are currently doing.

Our overall 1-2-1 general-organic-general chemistry course sequence is somewhat unusual, and we seek continuous improvement. Please help us by sending feedback: the best way to do this is by doing the daily surveys, providing me with constructive suggestions during or after the semester, and participating in the CourseEvalUM program as described by the Provost:

> Your participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of our academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University as well as to the tenure and promotion process.

Finally, some students complain that this is a biochemistry course. It is not. It is a chemistry course in which many of the examples are chosen from biochemistry and biology. Try to let yourself enjoy the material and appreciate the universality of the ideas we develop. Also, this course is a prerequisite for BCHMs 461, 462, 463, 464, and 465, and understanding free energy, redox potentials, and acid-base titrations is essential in those classes. Please let me know if you think there is excessive overlap or disagreement among classes.

Mastering Chemistry System (60 points)

Mastering Chemistry is an on-line homework system that guides you through solving problems resembling those in the textbook. MC problem sets will be assigned sporadically. MC can be about finicky formatting and there is a learning curve, so the first couple of assignments cover this. The SmartWork system keeps track of your performance. **You can try problems as many times as you want and still get full credit, but assignments cannot be submitted late.** Your work is automatically submitted when it is due. The point of the on-line homework is to encourage you to keep up with the material. The only way to learn chemistry is to solve problems. For enrollment instructions, see below. Unfortunately, we were not able to negotiate for a two week trial.

I did not set up an "eText" course.

The class enrollment key for Mastering Chemistry is "C271F18KAHN" (case sensitive, no quotes)

Please USE YOUR OFFICIAL UNIVERSITY EMAIL ADDRESS for your Mastering Chemistry account.

See the ELMS site for Pearson's instructions on registering for Mastering Chemistry

"Muddy/Clear" Surveys

After most classes, you will be expected to complete a short survey on ELMS covering some aspect of the lecture. I use this in lieu of clickers to try to stay calibrated on whether the class is appropriately paced or to identify ideas that need to be retaught. Answers are anonymous, but if I am sufficiently upset by a response I can find out who posted it. You get 50 points *in toto* for the surveys. These are basically free points: don't leave them on the table.

In-class participatory demonstrations

During some classes, I will ask students or groups of students to come up to the board to work problems. When I do this, I do not expect you to get the right answer. We are interested in the reasoning leading to an answer, and frequently I set you up to get interesting wrong answers. This should be a low-stress experience. You can always opt out. We will also do in-class experiments with Matlab or Excel, and if I ask you to explain the results of these experiments I similarly do not necessarily expect correct answers.

The Elevate program run by the TLTC on campus inspired me to do some of these exercises.

To succeed in this course, you must keep up.
Attend every class even if you think you have seen some of the material before.
Read over and understand your notes (ideally, rework them) before the next lecture.
Do the assigned reading and problems.
Create a framework of knowledge into which to fit facts, don't try to just memorize.
If you fall behind, it will just get worse. Stay engaged!
And…Allow yourself to enjoy the material!

Approximate Lecture Schedule (Exam dates are fixed)

ALL READING ASSIGNMENTS REFER TO TRO

I. Introduction

1.	Introduction, review of gas laws and the meaning of temperature; Chapters E,10	M, 8/27/18

II. Chemical Kinetics

2.	Dynamic equilibrium. The Maxwell-Boltzmann distribution	W, 8/29/18
→ Labor Day, no class		**M, 9/3/18**
3.	Reaction rates, reaction order, rate constants; 14.1-14.4	W, 9/5/18
4.	Differential and integrated rate laws; 14.4-14.5	M, 9/10/18
5.	Arrhenius equation; activation energies; 14.6	W, 9/12/18
6.	Reaction mechanisms, steady-state approximation, catalysis; 14.7-14.8	M, 9/17/18
→ Quiz I (20 pts) will be given in Discussion this week (9/18 and 9/20)		
7.	Catch-up day	W, 9/19/18

III. Chemical Equilibria, especially acid-base.

8.	Chemical equilibrium and LeChatelier's principle; Chapter 15	M, 9/24/18
9.	The Equilibrium Constant K_{eq} and calculations using it.	W, 9/26/18
10.	Eyring theory, free energy reaction coordinate diagrams	M, 10/1/18
→ EXAM I ← Covers through Lecture 10 (midterm grades due 10/22)		**W, 10/3/18**
11.	Acid-base reactions and the pH scale; 16.1-16.4	M, 10/8/18
12.	K_a, pK_a, K_w, K_b, pK_b, Lewis acids and bases; 16.5-16.11	W, 10/10/18
13.	Henderson-Hasselbalch equation, buffers and titrations; 17.1-17.4	M, 10/15/18
14.	Catch up and review acid-base	W, 10/17/18
15.	Special Topic I: Ionizable groups in proteins and enzymes	M, 10/22/18
16.	Protonation/deprotonation in oxygen transport by hemoglobin	W, 10/24/18

IV. Thermodynamics

17.	Review of thermochemistry and Hess's Law; Chapter 9.1-9.10	M, 10/29/18
→ EXAM II ← Covers through Lecture 16 (before drop date 11/5/18)		**W, 10/31/18**
18.	Energy, heat and work, enthalpy, state functions; Nash, Tro 18.1-18.4; 18.7	M, 11/5/18
19.	Statistical basis of entropy; Nash, Tro 18.1-18.4; 18.7	W, 11/7/18
20.	Third law, Free energy and chemical equilibrium; 18.6-18.10	M, 11/12/18
21.	Review of thermodynamics; van't Hoff equation, heat capacity	W, 11/14/18
22.	Special Topic II: DNA hybridization and its applications	M, 11/19/18
→ Thanksgiving Break 11/21/18-11/25/18		

V. Electrochemistry

22.	Electrochemical cells; 19.1-19.3	M, 11/26/18
23.	Standard reduction potentials; 19.4	W, 11/28/18
→ Quiz II (20 pts) will be given in Discussion this week (12/2 and 12/4)		
24.	The Nernst equation and calculation of equilibrium constants; 19.5-19.6	M, 12/3/18
25.	Catch-up and review; Special Topic III: Anaerobic metabolism	W, 12/5/18
26.	Overall wrap up; thermodynamics and economics of climate change	M, 12/10/18

→ FINAL EXAM ← **Thursday, 12/13/18, 10:30 a.m.–12:30 p.m.**

The final is comprehensive in principle, but it will emphasize the last part of the course.

Learning Outcomes

What do I want you to get out of this class?

In any Chemistry course, you will learn many details that will need to be memorized, and therefore can be rapidly forgotten. The Arrhenius equation will always be a click away on Wikipedia—why memorize it? If that is all there is to chemistry, then why is it that someone typically other than yourself has decided that you must take this course? There must be some skill you should retain after taking this course that cannot simply be mimicked by Googling. The answer is that the details and the approaches of chemistry are needed to assemble a way of thinking, and we want that way of thinking to stay with you after the details have faded into nostalgia.

What are the tenets of the chemistry way of thinking? Here are some: The universe operates subject to fundamental physical/chemical principles. To understand how the material world behaves, we must understand molecular-level properties and how they translate to bulk properties. Chemistry is the central science, and the principles of chemical bonding and reactivity, redox, kinetics, and thermodynamics are essential to understanding physics, biology, materials science, and engineering.

The meta-question is why society believes that the biological and chemical sciences are worth supporting even in the face of many other competing priorities. Besides just curiosity, the obvious answer is that all of us want to live longer, healthier, more productive lives. We want to use chemical and life science knowledge to improve our food, technology, environmental stewardship, and society. To be an informed citizen in the 21st century you need to know some chemistry, so I want you to retain enough of what we learn here to make well-reasoned decisions about the technical, ethical, and moral opportunities and hazards of new advances.

When you fill out your CourseEvalUM evaluations, please reflect on how well the material you actually learned is aligned with these ambitious goals.

Syllabus Date and version: August 26, 2018, v. 1.00