CHEM 162 - Thermodynamics and Kinetics

Spring 2012, MWF 8:30-9:20, Angell B-112

Prof. W.R. Leenstra

Introduction

Chem 162 is the second half of the year-long course in physical chemistry and covers the disciplines of thermodynamics and kinetics (and an introduction to statistical mechanics if time allows). Whereas the preceding course, Chem 161 - Quantum Chemistry, looks at chemistry from the ground up (electrons to atoms to molecules), in this course we will explore a variety of chemical properties from a macroscopic perspective. The topics themselves are expansions on ones introduced in the first-year course in chemistry.

Textbook

The textbook we will be using is "Physical Chemistry" by David Ball. This is a new book for Chem 162. We will cover the topics discussed in chapters 1-7, and 20. As those who have taken the first semester know, there is much more material in these chapters than can be reasonably covered in this second semester. While this textbook was chosen for its down-to-earth writing style, and because it appears to mirror my pedagogic approach, you should understand that for most upper level courses the textbook is an aid, not the "bible". Depending on the material/chapter, various sub-topics will not be covered in class (or the reverse). The rule of thumb to use in this course is that if a concept is not discussed in lecture, you don't need to know the corresponding passage of a chapter; however, you are responsible for all material discussed in class. Also, be aware that much of the content may be presented by me differently from the way the author has done a given topic. Occasionally I will copy passages out of other books when such might be helpful as an additional resource for you.

Minor, Prerequisites, Preparation

Chem 162 is one of the courses that can be used to fulfill the minor in Chemistry, after a year of organic chemistry. One other option, this spring semester, is Chem 131 (Inorganic Chemistry). The difference lies in the prerequisites. Whereas Chem 131 requires concurrent enrollment in the second semester of organic chemistry, this course in physical chemistry requires a year of physics, plus a year of calculus. As you would see in a cursory inspection of the first few chapters of our textbook, you would be quite lost without that one year of calculus already mastered.

Office Hours

My office is Cook A-119. I can be available at almost any time by appointment, and would especially encourage small groups of you to aggregate, and then schedule a group session. I will be available in my office Monday, Wednesday, and Friday 10:00-11:00 AM; if I happen to not be there due to another engagement, please let me know you tried to see me, and we'll reschedule. I encourage you very strongly to use these times to clear up difficulties in understanding the material as soon as possible. The only time I will not answer questions is on the day of the exam because I want to discourage "cramming" at the last moments.

Topics

The topics, in order of discussion, are as follows.

- Zeroth law of thermodynamics; modifications from the ideal gas law
- First law of thermodynamics: heat, work, energy, enthalpy
- Second/third laws of thermodynamics; the Carnot cycle and entropy
- Gibbs free energy and chemical potential; the Maxwell relations
- Chemical equilibrium
- Clausius-Clapeyron equation; phase diagrams
- Solutions; Raoult's law and deviations from ideality
- Kinetics of reactions; mechanisms of reactions from rate laws

These topics follow the chapter order of our text. However, as mentioned before, we will not take up every detail of what is in each chapter, and some chapters may be unexplored in their entirety.

Course Grading

Assessments will be carried out in three different categories: exams, homework, and final with point assignments of 300, 100, and 200, respectively. These are:

Exams. We will have three semester exams at approximately equal intervals. From experience, I know that students appreciate not having the one-hour time constraint for their exams. Instead, I will design exams that can be finished in less than two hours, and have them outside of lecture's class times, tentatively on Tuesday evenings from 6 p.m. till 8 p.m. The three exams are spread out as evenly as possible on the following schedule:

Exam 1 — February 21, covering material of 14 lectures (1-14)
Exam 2 — March 27, covering material of 12 lectures (15-26)
Exam 3 — April 24, covering material of 12 lectures (27-38)

I do not give make-up exams. If your schedule does not fit with these dates/times, I will allow some flexibility in your exam start time on those days, but you should arrange that with me well ahead of the exam date. Exams count as 100 points each, for a total of 300 points. In general terms, on exams will appear a mix of calculational problems, short-answer questions, longer-answer explanations, and multiple choice questions.

Homework. The content in this course is pretty challenging and very extensive, so in order to encourage you to keep up with the material in manageable pieces, I will assign regular HW sets that illustrate the concepts I feel are important (and would form a model for exam questions). These sets are not to be turned in - they are to be done for your own benefit. However, I will assign a homework problem or two almost every time we have a lecture. Each homework set will be worth a maximum of 3 points. You will earn 3 points for doing it correctly, with all the steps shown and documented in proper English, and presented professionally; 2 points for doing it correctly but either not all of the steps shown and documented, and/or turning in a sloppy job;

1 point for not doing it correctly; and 0 for not turning anything in. The particular problem will be assigned during a given lecture, and will be collected at the beginning of the following lecture (i.e., drop it off upon entering the classroom). Anything not turned it by the start of lecture is late; you can submit late HW, but there is a penalty of 1 point for each 24-hour period it is late, with the latest acceptable being the start of the next period. Out of the ~43 lectures this semester, I will assign and collect approximately 33 homework problems. At any rate, the total points accumulated for your homework will be normalized to 100 points possible, the equivalent of one exam.

Final. Our final exam is scheduled for Monday, May 7, at 7:30 AM in our regular classroom. It is cumulative (comprehensive) in nature, and multiple-choice in format. Many of the questions will come straight from the ACS standardized tests, and will be worth 200 points. Please plan your travel with this date constraint in mind.

Grade. Your grade for the course will be based on the total number of points you accumulate out of 600, relative to the class average. Thus, there is no meaningful letter grade that can be assigned to any one exam. I can only indicate approximate ranges based on a "curve". Although I can not at this time predict the difficulty of the exams and the overall strength of the class, I can say that the average score for the course was around 70% last year. In a large statistical sample, for this course the average performance earns a B-/B. Note that the average can shift to either end depending on the overall performance of the class. This grading scheme is based on the assumption that attendance is perfect, that students come prepared, and are engaged.

Lecture Notes

I will post lecture notes on Blackboard (bb.uvm.edu), as soon after the class as I can pretty up my own notes for you. This gives you the option of not taking notes, taking skeleton notes, or taking full-blown notes and then comparing. Remember that my notes will guide you as to what we skip in the book.

Responsibilities

It should go without saying that you are expected to show up to each class. Secondly, I expect you to come prepared for each lecture by having reviewed the material from the previous lecture, and having read the pertinent parts of the textbook. And finally, I expect you to be alert and ready to participate in class. If you are indeed too exhausted to keep your eyes open, I will ask you to leave the classroom. I consider this a simple matter of common courtesy and mutual respect.