Syllabus for Chemistry 561, Fall 2019

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Textbook: Atkins and de Paula, "Physical Chemistry," Vol. 1 (paperback) 11th Edition, 2018. You may instead buy the whole hardbound book, but there is no guarantee that it will be used in the semester in which you take Chemistry 562. Volume 2 covers the material for that course.

Why you should learn this material: Physical chemistry utilizes both macroscopic and microscopic viewpoints. Thermodynamics is the most powerful *macroscopic* description available to chemists; it is the foundation for much of modern science. The kinetic theory of gases, in contrast, introduces a rigorous *microscopic* view of the collisions that underpin gas laws and chemical reactivity in the gas phase. The course material allows important insights into problems facing our society and our planet.

Topics Covered: We will go through a comprehensive treatment of the First, Second, and Third Laws of Thermodynamics from a classical perspective. All the usual state functions will be introduced and explained: internal energy, enthalpy, heat capacity, entropy, Gibbs and Helmholtz free energies, and chemical potential. The temperature dependence of all of these will be derived and illustrated. The relationship of these to equilibrium constants and the temperature dependence of equilibrium constants will be a major topic. Examples of the treatment of chemical equilibrium, including in electrochemistry, will be emphasized. The thermodynamic treatment of phase equilibrium, including colligative properties, will be covered. The kinetic theory of gases and the behavior of non-ideal gases will be introduced and explored. Other key subjects are chemical kinetics and transport properties such as diffusion and conductance.

Learning Outcomes: You will be able to: 1) derive important thermodynamic relationships from the three laws of thermodynamics, 2) apply the three laws of thermodynamics to physical and chemical systems, and 3) make connections between microscopic and macroscopic descriptions of chemical kinetics. You will also become proficient in using EXCEL to solve physical chemistry problems and plot results.

Problems Sets: In physical chemistry, mastery of a concept is exhibited by the ability to solve problems. Mathematics is an integral part of physical chemistry and you need to understand the math well enough to solve the problems. It is expected that you will work and understand all the assigned problems.

Problem sets will be due when they are announced due, but this will be very approximately once per week. They will be due at the beginning of class on the due date. Late problem sets will not be accepted except by explicit permission of the instructor in special circumstances. Graded problem sets will be returned in class. The accumulated homework grade will count towards final semester grade total. Even more important is the fact that the tests are in large measure

based on the problem sets. In previous years, there has been a high correlation between problem set scores and exam scores.

You are permitted to work on your problem sets in a study group. Each person, however, **must** hand in their own solutions to the problem set and should fully understand the solutions.

Mathematical Software: We will use EXCEL extensively on the problem sets, and it is expected that students will become skilled at using it. Assignments in EXCEL must be printed out in full, on paper, including all tables and data, as well as plots, for submission, unless there are specific instructions to the contrary. It is encouraged that you annotate your EXCEL assignments to make them understandable to whoever may read them, including yourself later, *e.g.*, in studying for tests. This may be done by using EXCEL itself, or by putting handwritten comments on the paper.

Class Participation: Active participation in class and in the discussion sections will help you learn and can help you earn a good grade. Asking questions or bringing up points for discussion in class are encouraged. Attendance in and participation in all discussion sections is expected.

Tests: There will be two evening tests during the semester "midterms" on dates to be announced later. There will also be a cumulative final examination at the time and place selected by the University.

Point Breakdown: Two Mid-term exams (100 points each), final exam (200 points), and problem sets (50 points total).

Course Grade: Final course letter grades will be determined by RCW and KJ *at the end of the semester*. In no case will the letter grades be in a different order than the numerical point total just described. Letter grades will also be assigned to each graded test and to the homework total. The cutoffs for final letter grades will be determined *objectively* by consideration of student's letter grades on tests and homework, experience from previous semesters, typical Chemistry Department class grade distributions, where clear breaks in the sequence of numerical scores occur, and possibly other factors. Letter grades on tests should therefore at least be a reasonable indicator of letter grades for the semester.