SYLLABUS

CH3500 PHYSICAL CHEMISTRY for the Environmental and Life Sciences FALL, 2001

INSTRUCTOR: Richard E. Brown
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Office hours: by appointment

TEXT: Physical Chemistry, Principles and Applications in Biological Sciences, 4th.
Ed., Tinoco, Sauer, & Wang

GRADING:

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<tr>
<td>Hour Exam I</td>
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<td>Hour Exam II</td>
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<tr>
<td>Final Exam</td>
<td>200 points</td>
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<td>Total</td>
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The course will be graded on the basis of two hour exams and a final exam. There are no predefined grade breaks or scoring scale for the exams. In order for the student to evaluate his or her standing in the course, after each exam, the breaks for the grades will be given. The exams will include both multiple choice type problems and partial credit type problems where you must show your work for partial credit. Re-grades for any exam must be requested within one week after the return of the exam.

With 15 weeks in the semester and two hour exams, there will be approximately 28 lectures to cover a wide variety of topics. The following course outline includes the chapters of the textbook and topics to be covered. However, if the lecture schedule falls behind, some sections will be dropped. The exams will be given during the evenings with the dates, topics and times announced one to two weeks in advance. Although the lecture prior to the exam will be cancelled, the lecturer will be present in the lecture hall to go over problems and answer questions that the students may have. Extra problem sessions may be scheduled as needed during the evening hours.

Practice problems from the textbook will be assigned during the course. Although these will not be collected or graded, it is recommended that you solve as many as possible to gain experience with the kind of problems, which will be on the exams.
An unexcused absence will be an automatic zero on the exam. If you plan to be absent for some valid reason, (e.g., a field trip, job interview, athletic event, etc.), notify the instructor prior to the exam. If an unanticipated problem makes it impossible to attend the exam, notify the instructor as soon as possible. An extended delay will be considered to be an unexcused absence.

Throughout the course, information will be made available on the WebCT site for the course, which can be accessed at http://courses.mtu.edu/. Please access this site often for information such as the syllabus, exam notices and solutions, etc.

**COURSE OUTLINE:**

**Chapter 1.**  Introduction (reading assignment)

**Chapter 2.  The First Law of Thermodynamics**
1. definition of a thermodynamic system, laws for ideal & real gases (a review)
2. energy, work, types of work, heat, heat capacities, pressure-volume work for non-constant pressure
3. energy changes, (ΔE) in terms of heat and work, the first law of thermodynamics, reversible change of state
4. enthalpy (H), meaning of enthalpy changes (ΔH), path independence of ΔE & ΔH
5. pressure and temperature dependence of ΔE & ΔH for pure substances, ΔE & ΔH for phase changes
6. ΔE & ΔH for chemical reactions, enthalpy (heat) of formation, (ΔHf), bond energies

**Chapter 3.  The Second and Third Laws of Thermodynamics**
1. the Carnot cycle
2. entropy, (S), and entropy changes, (ΔS), the second law of thermodynamics, the temperature and pressure dependence of S and ΔS
3. ΔS for phase changes and chemical reactions, the third law of thermodynamics, measurement of absolute entropies
4. Gibbs free energy, (G), and the chemical potential, (μ), the determination and use of ΔG
5. pressure dependence of G, the basic equation, the Helmholtz free energy, (A)
6. using partial derivatives to derive some fundamental equations

**Chapter 4.  Chemical Equilibria**
1. ΔG for gas phase chemical reactions, Gibbs free energy of formation, (ΔGf), ΔG and the reaction quotient, (Q) and the equilibrium constant, (K), nonideal behavior, activity, the activity coefficient
2. partial molar free energy, the chemical potential, the standard states for pure gases, liquids and solids, standard states for the solvent and the solute in solutions
3. temperature dependence of the equilibrium constant, equilibrium calculations
4. electrochemistry and galvanic (Voltaic) cells, cell potentials and electrode potentials, the standard electrode potential, the concentration dependence of cell potentials
5. activity coefficients of ions, the Dye-Huckel limiting law, some biological applications of electrochemistry, partial molal quantities

Chapter 5. Physical Equilibria
1. phase equilibria of pure substances, phase equilibria of solutions, phase equilibria across membranes
2. surface tension, applications to biological membranes, the phase rule

Chapter 6. Transport Theory
1. the kinetic molecular theory, the Maxwell-Boltzmann distribution
2. diffusion and Fick's laws, some applications (sedimentation, viscosity, electrophoresis)

Chapters 7 & 8. Kinetics
1. definition of the rate of a reaction, elementary versus complex reactions, the differential rate law and reactions orders: zero, first and second orders
2. the integrated rate equations: zero, first and second orders, half lifes and relaxation times, the experimental determination of the rate equation
3. reaction mechanisms: sequential and parallel reactions, steady state approximation
4. effect of temperature on reaction rates, the Arrhenius equation, transition state theory
5. the kinetics of ionic reactions, the Debye-Huckel limiting law, diffusion controlled reactions
6. catalysis and enzyme kinetics, the Michaelis-Menten equation, mechanism of enzymatic reactions