SYLLABUS

CH3500

PHYSICAL CHEMISTRY

for the

Environmental and Life Sciences

FALL, 2004

INSTRUCTOR:

Richard E. Brown
Phone: 487-2383
Email: rebrown@mtu.edu
Office hours: by appointment


GRADING:

<table>
<thead>
<tr>
<th>Problems</th>
<th>Value</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Sets</td>
<td>100 points</td>
<td>1st Law of Thermodynamics</td>
</tr>
<tr>
<td>Hour Exam I</td>
<td>100 points</td>
<td>2nd and 3rd Laws of Thermo.</td>
</tr>
<tr>
<td>Hour Exam II</td>
<td>100 points</td>
<td>Equilibrium and Kinetics</td>
</tr>
<tr>
<td>Final Exam</td>
<td>100 points</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>400 points</td>
<td></td>
</tr>
</tbody>
</table>

The course will be graded on the basis of two hour exams, a final exam and three problem sets. 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. Three problem sets will be handed out during the course that will be turned in and graded. These three sets will collectively be worth 25% of your final course grade and will be graded on a straight standard scale. Additional 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.

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.

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, copies of old exams, exam notices and solutions, etc.
COURSE OUTLINE:

Chapter 1. Introduction
1. definition of temperature
2. definition of a thermodynamic system
3. equations of state
4. laws for ideal & real gases

Chapter 2. The First Law of Thermodynamics
1. energy, work, types of work, heat, heat capacities, pressure-volume work for non-constant pressure
2. energy changes, (ΔE) in terms of heat and work, the first law of thermodynamics, reversible change of state
3. enthalpy (H), meaning of enthalpy changes (ΔH), path independence of ΔE & ΔH
4. dependence of state functions and heat capacities on P, V & T, the Joule Thompson coefficient
5. ΔE & ΔH for phase changes & chemical reactions, enthalpy (heat) of formation, (ΔHf)
6. determining ΔE & ΔH values for reactions at different temperatures

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, dependence of S and ΔS on P, V and T
3. ΔS for phase changes and chemical reactions, the third law of thermodynamics, entropy and disorder, measurement of absolute entropies

Chapter 4. Free Energy and the Chemical Potential
1. spontaneity, the Gibbs (G) and Helmholtz (A) free energies, their significance and use
2. the basic equations, the Maxwell relationships
3. pressure and temperature dependence of G, fugacity, the chemical potential (μ)

Chapters 5, 6 & 8. Chemical and Phase Equilibria
1. ΔG for gas phase chemical reactions, Gibbs free energy of formation, (ΔGo), 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. single component phase transitions and diagrams, the Clapeyron & Clausius-Clapeyron equations
5. electrochemistry and galvanic (Voltaic) cells, cell potentials and electrode potentials, the standard electrode potential, the concentration dependence of cell potentials
6. ions in solution, activity coefficients of ions, the Debye-Huckel limiting law

Chapter 20. 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 lives and relaxation times, the experimental determination of the rate equation
3. effect of temperature on reaction rates, the Arrhenius equation
4. reaction mechanisms, sequential and parallel reactions
5. steady state approximation, transition state theory
6. catalysis and enzyme kinetics, the Michaelis-Menten equation, mechanism of enzymatic reactions