

FCH 360: Physical Chemistry I

SYLLABUS

(The following outlines topics discussed in this class during the previous year. It is anticipated to be representative of the subjects to be treated this year as well, although detailed content may vary at the discretion of the instructor.)

Gas Laws:

Ideal gases, virial coefficients, and real gases. Equations of state, such as the Van der Waals equation. Physical significance of the Van der Waals “*a*” and “*b*” parameters. Law of corresponding states.

Kinetic molecular theory of ideal gases; Maxwell-Boltzmann distributions for velocities and speeds. Mean, root-mean-squared (RMS), and most probable speeds as functions of temperature and molecular weight.

First Law of Thermodynamics:

Conservation of energy, heat as a form of energy. Definitions of heat, work, and energy, and the calculation of work performed in various processes. Heat capacities and enthalpy, temperature dependence of enthalpy and energy. Standard states, and enthalpy changes for standard state processes. Adiabatic processes, and associated work and energy flows.

Second Law of Thermodynamics:

State functions and their properties. Consideration of engine efficiencies, motivation of entropy as a state function. Law of increase of entropy for adiabatically isolated systems. Changes in entropy associated with different types of process.

Criteria for spontaneity under constant P-T or V-T conditions, leading to Gibbs and Helmholtz Free Energies.

Third Law of Thermodynamics:

The Boltzmann definition of entropy in terms of number of accessible states; definition of standard molar entropies in terms of absolute zero of temperature. Connections with “counting” number of states available to system. Relationship of entropy to “disorder”.

Chemical Thermodynamics:

Maxwell relations as consequences of differentiability, *i.e.*, of the entropy and energy being state functions. The use of Maxwell relations to derive the dependence of energy on volume at a given temperature; connections with gas non-ideality.

Temperature and pressure dependence of the molar Gibbs energy; the chemical potential. First-order phase transitions of pure substances, simple phase diagrams. Response of vapor-liquid, solid-liquid, and solid-vapor equilibria to changes in pressure and temperature.

Mixture Thermodynamics:

Free energy, entropy, and volume changes on mixing (with focus upon ideal and regular mixtures). Elementary derivation of entropy of mixing under ideal conditions based on state-counting ideas. Raoult's Law. Colligative properties as originating from the vapor pressure lowering in dilute solutions; determination of molecular weights by measurement of colligative properties.

Phase Diagrams and Phase Rule:

Phases, components, and degrees of freedom. The Phase Rule. Recapitulation of phase diagrams for one-component systems.

Phase diagrams of two-component systems. Liquid-vapor phase diagrams; calculation of vapor and liquid phase compositions for ideal mixtures. Pressure-composition and temperature-composition diagrams; qualitative discussion of distillation.

Liquid-liquid and solid-liquid phase diagrams for binary systems, qualitative discussion. Use of lever rule for obtaining relative amounts of phases in equilibrium with each other under given conditions.

Chemical Equilibria:

Thermodynamic equilibrium constants and their relation to free energies of reaction; responses of equilibria to alterations in pressure, temperature, and presence of inert components. Applications of the principle of Le Chatelier.

In case time permits:**Electrolyte Solutions and Electrochemistry:**

Activities and activity coefficients for ionic solutions; the Debye-Huckel limiting law; half-reactions and electrodes; standard cell potentials; the Nernst equation, and relations between cell potentials, free energies, and solubility constants.

A note regarding the academic calendar and religious observances:

As part of the new Academic Calendar being implemented this year, this fall (Fall 2011) will be the first semester during which SU and ESF will not include scheduled “non-instructional days” for any religious observances.

It should go without saying that any student who is unable because of his or her religious beliefs to attend classes on a particular day or days shall be excused from any examination or study requirements.

Insofar as possible, I have tried to take days and dates for religious observances into account in formulating a schedule for the semester. Being present for lecture is not mandatory for this course. Attendance is neither recorded nor taken. Every effort will be made to provide flexibility in terms of when homework assignments are due to be turned in.

Nevertheless, in case it turns out that there is an examination scheduled or an assignment that is due on a day when a student is unable to attend class in order to fulfill a religious observance, the person (or persons) affected are encouraged to inform me as early as convenient so that I can make alternative arrangements to accommodate their needs. Either (i) an email message sent to me, or: (ii) a written note placed in my mailbox or provided to me in person, with your name and the day(s) where a conflict arises with a religious observation, should suffice.

In keeping with the policy adopted by SU, which can be found at:

http://supolicies.syr.edu/emp_ben/religious_observance.htm ,

students should notify me regarding such conflicts not later than the end of the second week of classes. Obviously, the above does *not* apply to days that correspond to religious observances that fall within the first two weeks of class.