Chemistry 1150 - Spring 2014

Physical Chemistry: Thermodynamics and Statistical Mechanics

Professor: Lai-Sheng Wang, Geo-Chem 249B (e-mail: Lai-Sheng_Wang@brown.edu)

Textbook: D. A. McQuarrie and J. D. Simon, *Physical Chemistry: A Molecular Approach*

Lectures: MWF, 10:00 – 10:50 am, Geo-Chem 351

Office hours: Mon: 11am -12 noon; Tue: 4-5 pm. If the scheduled hours do not work for you, please email me for an appointment.

TA: Zachary Piazza (zachary_piazza@brown.edu) (Geo-Chem 249)
Office hours: Wed: 1:30-3:30 pm
Office hour location: Science Library, Floor A, the Collaborative Work room

Home works: There will be a weekly home-work set and reading assignments

MathChapters: Although I will not assign them as homework, I strongly urge you to review the MathChapters in the text to refresh your basic math skills.

Exams: Two one-hour in class exams plus a final exam

Grading: 25% home work, 30% mid-terms, 35% final, 10% class participation

Stand-in lectures: Due to prearranged conference travels, Zach Piazza will give the lectures on March 3, 5, 17 & 19.

Course Outline

No. of lectures

Chapter 16: The Properties of Gases **3**

Ideal and non-ideal gases, compressibility factor, van der Waals and virial equations of state, the law of corresponding states, the second virial coefficient and intermolecular interactions

Chapter 17: The Boltzmann Factor and Partition Functions **3**

The concepts of systems and ensembles, the partition function and properties of macroscopic systems, partition functions of systems consisting of distinguishable and indistinguishable particles, molecular partition functions

Chapter 18: Partition Functions of Ideal Gases **2**

Translational partition function, vibrational and rotational partition functions of diatomic molecules, energies and heat capacities of ideal gases

Chapter 19: The First Law of Thermodynamics **4**

Work, heat, energy, and enthalpy, state and non-state functions, reversible and irreversible processes, isothermal and adiabatic processes, heat capacities, and heats of phase transitions and chemical reactions

Mid-term 1

Chapter 20: The Second Law of Thermodynamics **3**

Entropy and spontaneous processes, second law of thermodynamics, maximum efficiency of a heat engine, entropy and disorder

Chapter 21: Entropy and the Third Law of Thermodynamics **2**

The third law of thermodynamics and the absolute entropy of a substance, standard molar entropies of molecules, entropy changes of chemical reactions

Chapter 22: Helmholtz and Gibbs Energies **3**

Directions of spontaneous processes and the Helmholtz and Gibbs energies, Maxwell relations, natural independent variables of thermodynamic functions, the Gibbs-Helmholtz equation, fugacity and nonideality of a gas

Chapter 23: Phase Equilibria **3**

Phase diagrams and Gibbs energies, chemical potentials, the Clapeyron equation and melting temperatures, the Clausius-Clapeyron equation and vapor pressures of substances

Mid-term 2

Chapter 24: Liquid-Liquid Solutions **3**

The chemical potential and partial molar quantities, the Gibbs-Duhem equation, ideal solutions, Raoult's law and Henry's law, pressure-composition diagrams, nonideal solutions and activities

Chapter 25: Solid-Liquid Solutions **3**

Solute-solvent systems, activities of nonvolatile solutes, colligative properties of diluted solutions: depression of melting points and osmotic pressures, electrolyte solutions and the Debye-Huckel theory

Chapter 26: Chemical Equilibrium **4**

Extent of reactions, equilibrium constants and standard Gibbs energies of formation, reaction quotient and directions of chemical reactions, the Van't Hoff equation, equilibrium constants and partition functions, activities and chemical equilibrium of condensed phase reactions

Chapter 27: The Kinetic Theory of Gases **3**

Average translational energies of gas molecules, distribution of molecular speeds, collision frequencies, mean free path, and supersonic molecular beams

Research Lecture: Solution chemistry in the gas phase **1**

Final