CHE 110C — Physical Chemistry: Thermodynamics, Equilibria & Kinetics

Department of Chemistry Syllabus

This syllabi is advisory only. For details on a particular instructor's syllabus (including books), consult the instructor's course page. For a list of what courses are being taught each quarter, refer to the Courses page. *Every instructor has prerogative to teach the course as they see fit and ultimately the instructor's syllabus supersedes all others.*

Chemistry 110C Physical Chemistry: Thermodynamics and Kinetics

Approved:

Suggested Textbook: (actual textbook varies by instructor; check your instructor)

Physical Chemistry: A Molecular Approach. McQuarrie, Donald A.; Simon, John D. University Science Books, 1997. ISBN 10: 0935702997. ISBN 13: 9780935702996.

This course will cover Chapters 19-31.
Exams: There will be two midterm exams and a final.

Suggested Schedule:

Week 1

Internal energy of a macroscopic body. Statistical and thermodynamic equilibrium.
Temperature. Boltzmann factor. Average energy.
Heat and Work. First Law of thermodynamics.
Enthalpy.

Week 2
Entropy. Second Law of thermodynamics.
Calculation of entropy. Boltzmann formula. Examples of entropy calculation. Entropy of water.
Calculation of entropy change II. Ideal gases, solids and liquids.

Week 3
Reversible and Irreversible processes.
Energy/work from a non-equilibrium system. Carnot's theorem. Carnot engine.
Helmholtz free energy. Gibbs free energy. Enthalpy- and Entropy-driven processes.

Week 4
System at equilibrium. State Functions.
Quasi-equilibrium reversible change. Maxwell differential relations for state functions.
Maxwell differential relations II. Gibbs and Helmholtz free energy change. Equation of state.
MT I

Week 5
Chemical Potential. Boltzmann Phase Equilibria. Phase diagrams. Critical point, triple point.
Clausius-Clapeyron equiation. Melting and Freezing under pressure.
Liquid-vapor equilibrium. Vapor pressure. Boiling.

Week 6
Solutions. Chemical potential of solvent and solute.
Change of boiling temperature and melting temperature of a solution.
Osmotic pressure. Reverse osmosis .
Vapor pressure of a solution. Raoul's Law.
Solubility of gases. Henry's Law. Oxygen in water.

Week 7
Chemical equilibrium. Equilibrium Constants.
Binding and dissociation constants. Enzymes and substrate binding.
Acid-base equilibrium. Protons in water. pKa of an acid. pKa of water. Hydronium ion.

MT II

Week 8
Chemical Kinetics. Unimolecular and Bimolecular rate constants.
Relation to thermodynamics and equilibrium constants.
Rates for dissociation and protonation of acid .

Week 9
Unimolecular rate constant. Transition State Theory. Activation energy, activation entropy. Arrhenius equation.
Bimolecular reactions in solutions. Diffusion-limited rate.
Diffusion in liquids. Diffusion rate, diffusion constant. Einstein-Stokes equation.
Diffusion of protons. Grotthuss mechanism. Diffusion rate of protons.
Bimolecular rate constant. Enzyme-substrate reactions. Protonation and deprotonation of acids.
Catalysis. Michaelis-Menten Kinetics.

Week 10
Kinetic theory of gases. Chemical reactions in gases. Maxwell distribution.
Number of collisions with a wall.
Collision frequency in gases.
Mean free path.
Diffusion in gases.
Viscosity of gases.
Bimolecular chemical reactions in gases.

Final Exam

Additional Notes: