

Chemistry C2407, Fall 2003

Outline of Course content

Instructor: George Flynn

Meeting Time: TTh, 1:10 p.m.

All information contained in this handout can be found at the C2407 course website:

<http://www.columbia.edu/itc/chemistry/chem-c2407/>

I) Kinetic Theory of Gases

- 1) An Observation about gases
- 2) Review of physics of kinematics
- 3) A simplified Kinetic Theory Model
- 4) Kinetic energy and absolute temperature
- 5) Typical molecular speeds
- 6) Effusion
- 7) Heat Capacity
- 8) Definition of work at constant pressure
- 9) Collisions between molecules
- 10) Mean free path
- 11) Boltzmann speed distribution
- 12) Various definitions of average speeds

II) Binary Collision Model for Chemical Reactions

- 1) Reactions occur during collisions
- 2) Collision frequency/kinetic rate constant
- 3) Relative speed
- 4) Energy requirements/reaction barriers
- 5) All or nothing activated state model
- 6) Arrhenius reaction model
- 7) Temperature Dependence of rate constant
- 8) Orientation effect

III) Chemical Kinetics

- 1) Definitions: reaction rate and reaction order
- 2) First order kinetics
- 3) Half time for first order reactions
- 4) Second order kinetics
- 5) Half life for second order reactions
- 6) Initial rates method
- 7) Mechanisms and elementary reactions
- 8) Unimolecular decompositions
 - a) The Lindemann Mechanism
 - b) The steady state approximation
 - c) Results for limiting cases
- 9) Catalysis
 - a) Enzyme kinetics
 - b) Michaelis-Menten Model
- 10) Temperature dependence of rate constants
- 11) Relationship between rate constant and equilibrium constant

IV) Acid-Base Equilibria

- 1) Definitions of acid/base properties
- 2) The acid and base ionization constants
- 3) The ion product of water
- 4) Weak acids and weak bases
- 5) Hydrolysis
- 6) Buffers
- 7) Titrations of acids with bases
- 8) Indicators

V) Thermodynamics (I)

- 1) State functions
- 2) Properties independent of path
- 3) Work and heat
- 4) Work under variable pressure conditions
- 5) The first law of thermodynamics
- 6) Definition of Enthalpy, H
- 7) Standard Enthalpy
- 8) Enthalpy of formation and reaction
- 9) Enthalpy and heat capacity
- 10) Temperature dependence of ΔH

VI) Thermodynamics (II)

- 1) Entropy exists
- 2) Reversible and irreversible work
- 3) Definition of Entropy
- 4) The second law of thermodynamics
- 5) Properties of Entropy S (temperature dependence)
- 6) Third law of thermodynamics
- 7) Definition of free energy, G, and work function, A

VI) Thermodynamics (II) (cont.)

- 8) Spontaneous processes and ΔG
- 9) Pressure dependence of ΔG for an ideal gas
- 10) Standard free energy
- 11) Relationship between standard free energy and equilibrium constant

VII) Chemical Bonding in Polyatomic Molecules

- 1) Forming molecular orbitals from atomic orbitals: mathematics
- 2) Bonding and anti-bonding orbitals: 1s atomic orbital overlap/He₂, H₂
- 3) Bonding and anti-bonding orbitals: 2p atomic orbital overlap/2nd row diatomics
- 4) Bonding in polyatomic molecules
- 5) Hybridization of atomic orbitals: localized molecular orbitals
- 6) Hybridization and shape
- 7) Role of lone pair electrons
- 8) Multiple bonds in carbon compounds
- 9) Pi bonds: ethylene
- 10) Delocalized molecular orbitals: polyenes
- 11) Triple bonds: acetylene
- 12) Delocalized Pi bonds: benzene
- 13) Generalized delocalization: solids