COURSE OUTLINE FOR CHEM 102

Text: Chemistry A Molecular Approach, by Nivaldo J. Tro, First Edition

I. Chemical Kinetics (Chapter 13)

- A. Rate of a Chemical Reaction
  - 1. Measuring Reaction Rates
- B. The Rate Law: Effect of Concentration on Reaction Rate
  - 1. Determining the Order of a Reaction
  - 2. Reaction Order for Multiple Reactants
- C. The Integrated Rate Law: The Dependence of Concentration on Time
  - 1. Half Life
- D. The Effect of Temperature on Reaction Rate
  - 1. Collision Model
  - 2. Activation Energy
  - 3. The Arrhenius Equation
  - 4. Determining the Activation Energy
- E. Reaction Mechanisms
  - 1. Rate Laws for Elementary Steps
  - 2. Rate Determining Steps and Overall Reaction Rate Laws
  - 3. Reactions with a Fast Initial Step
- G. Catalysis

II. Chemical Equilibrium (Chapter 14)

- A. The Concept of Dynamic Equilibrium
- B. The Equilibrium Constant
  - 1. Expressing the Equilibrium Constants for Chemical Reactions
  - 2. Significance of the Equilibrium Constant
  - 3. Relationships Between the Equilibrium Constant and the Chemical Equation
- C. Expression of the Equilibrium Constant in Terms of Pressure
- D. Heterogeneous Equilibria
- E. Calculating Equilibrium Constants from Measured Equilibrium Concentrations
- F. The Reaction Quotient: Predicting the Direction of Change
- G. Finding Equilibrium Concentrations
- H. Le Chatelier's Principle

III. Acids and Bases (Chapter 15)

- A. The Nature of Acids and Bases
- B. Definitions of Acids and Bases
  - 1. Arrhenius Definition
  - 2. Bronsted-Lowry Definition
- C. The Autoionization of Water and pH
  - 1. The pH Scale
  - 1. The pOH and Other Scales
- D. Finding the Hydronium Ion Concentration and the pH of Strong and Weak Acid Solutions
  - 1. Percent Ionization of a Weak Acid
  - 2. Mixtures of Acids

E. Base Solutions
   1. Strong Bases
   2. Weak Bases
   3. Finding the Hydroxide Ion Concentration and the pH of Basic Solutions
F. Acid-Base Properties of Salt Solutions
   1. Anions as Weak Bases
   2. Cations as Weak Acids
   3. Classifying Salt Solutions as Acidic, Basic or Neutral
G. Polyprotic Acids
   1. Finding the pH of Polyprotic Acid Solutions
   2. Finding the Concentration of Anions for a Weak Diprotic Acid Solution
H. Acid Strength and Molecular Structure
I. Lewis Acids and Bases

IV. Aqueous Ionic Equilibrium (Chapter 16)

A. Buffers: Solutions That Resist pH Change
   1. Calculating the pH of a Buffer
   2. Henderson – Hasselbalch Equation
   3. Calculating pH Changes in a Buffer Solution
   4. Buffers Containing a Base and Its Conjugate Acid
B. Buffer Effectiveness: Buffer Range and Buffer Capacity
C. Titrations and Curves
   1. Strong Acid – Strong Base
   2. Weak Acid – Strong Base
   3. Titrations of Polyprotic Acids
   4. Indicators
D. Solubility Equilibria and The Solubility Product Constant
   1. K_{sp} and Molar Solubility
   2. K_{sp} and Relative Solubility
   3. Common-Ion Effect
   4. Solubility and pH
E. Precipitation and Separation of Ions
F. Qualitative Analysis for Metallic Elements
G. Complex Ion Equilibria

V. Thermochemistry (Chapter 6)

A. The Nature of Energy and Its Transformations
B. The First Law of Thermodynamics
   1. Internal Energy
   2. Relating the Change in Internal Energy to Heat and Work
   3. State Functions
C. Quantifying Heat and Work
D. Measuring ΔE for Chemical Reactions: Constant Volume Calorimetry
E. Enthalpy: The Heat Evolved in a Chemical Reaction at Constant Pressure
   1. Endothermic and Exothermic Processes
   2. Stoichiometry Involving ΔH
   3. Thermochemical Equations
F. Constant Pressure Calorimetry
G. Relationships Involving ΔH_{rxn}

1. Hess's Law

H. Enthalpies of Reaction from Standard Heats of Formation

VI. Free Energy and Thermodynamics (Chapter 17)

A. Spontaneous and Nonspontaneous Processes
B. Entropy and the Second Law of Thermodynamics
C. Heat Transfer and Changes in the Entropy of the Surroundings
   1. The Temperature Dependence of ΔS_{surr}
   2. Quantifying Entropy Changes in the Surroundings
D. Entropy Changes in Chemical Reactions
   1. Standard Molar Entropies
   2. Third Law of Thermodynamics
E. Gibbs Free Energy
   1. Calculation of ΔG^o from Enthalpy and Entropy Information
   2. Calculation of ΔG^o from Standard Free Energies of Formation
F. Free Energy Changes for Nonstandard States
G. Free Energy and the Equilibrium Constant

VII. Electrochemistry (Chapter 18)

A. Oxidation States
B. Balancing Oxidation-Reduction Equations
C. Voltaic (or Galvanic) Cells
   1. Electrochemical Cell Notation
D. Standard Reduction Potentials
   1. Predicting the Spontaneous Direction of an Oxidation-Reduction Reaction
   2. Predicting Whether a Metal Will Dissolve in Acid
E. Cell Potential, Free Energy and the Equilibrium Constant
   1. The Relationship Between ΔG^o and E^o_{cell}
   2. The Relationship Between K and E^o_{cell}
F. Cell Potential and Concentration
   1. The Nernst Equation
   2. Concentration Cells
G. Batteries: Using Chemistry to Generate Electricity
   1. Dry Cell Batteries
   2. Lead Acid Storage Batteries
   3. Fuel Cells
H. Electrolysis
   1. Predicting the Products of Electrolysis
   2. Stoichiometry of Electrolysis
I. Corrosion

VIII. Radioactivity and Nuclear Chemistry (Chapter 19)

A. Discovery of Radioactivity
B. Types of Radioactivity
   1. Alpha Decay
   2. Beta Decay
   3. Gamma Ray Emmision
   4. Positron Emission
   5. Electron Capture

C. Valley of Stability; Predicting the Type of Radioactivity
    1. Magic Numbers
    2. Radioactive Decay Series
D. Detection of Radioactivity
E. The Kinetics of Radioactive Decay
    1. The Integrated Rate Law
    2. Using Radioactivity to Measure the Age of Fossils and Artifacts
    3. Uranium/Lead Dating
F. The Discovery of Fission
G. Converting Mass into Energy: Mass Defect and Nuclear Binding Energy
H. Nuclear Fusion
I. Nuclear Transmutation and Transuranium Elements
J. The Effects of Radiation on Life
K. Radioactivity in Medicine and Other Applications

IX. Transition Metals and Coordination Compounds (Chapter 24)

A. Properties of Transition Metals
B. Coordination Compounds
C. Nomenclature of Coordination Compounds
D. Structure and Isomerism
E. Bonding in Coordination Compounds
    1. Valence Bond Theory
    2. Crystal Field Theory
    3. The Color of Complex Ions and Crystal Field Strength
    4. Magnetic Properties
F. Applications of Coordination Compounds
    1. Chelating Agents
    2. Chemical Analysis
    3. Coloring Agents
    4. Biomolecules