Chemistry 111 Syllabus

Chapter 1: Chemistry: The Science of Change

The Study of Chemistry
- Chemistry You May Already Know • The Scientific Method

Classification of Matter
- Pure Substances • States of Matter • Mixtures

The Properties of Matter
- Physical and Chemical Properties • Extensive and Intensive Properties

Scientific Measurement
- SI Base Units • Mass • Temperature
- Derived Units: Volume and Density

Uncertainty in Measurement
- Significant Figures • Calculations with Measured Numbers
- Accuracy and Precision

Using Units and Solving Problems
- Conversion Factors • Dimensional Analysis

Chapter 2: Atoms and the Periodic Table

Subatomic Particles and Atomic Structure
- Discovery of the Electron • Radioactivity
- The Proton and the Nuclear Model of the Atom • The Neutron

Atomic Number, Mass Number, and Isotopes

Average Atomic Mass

The Periodic Table

The Mole and Molar Masses
- The Mole • Molar Mass
- Interconverting Mass, Moles, and Numbers of Atoms

Chapter 3: Quantum Theory and the Electronic Structure of Atoms

Energy and Energy Changes
- Forms of Energy • Units of Energy

The Nature of Light
- Properties of Waves • The Electromagnetic Spectrum
- The Double Slit Experiment

Quantum Theory
- Quantization of Energy • Photons and the Photoelectric Effect

Bohr's Theory of the Hydrogen Atom
- Atomic Line Spectra • The Line Spectrum of Hydrogen

Wave Properties of Matter
- The de Broglie Hypothesis • Diffraction of Electrons

Quantum Mechanics
- The Uncertainty Principle • The Schrödinger Equation
- The Quantum Mechanical Description of the Hydrogen Atom

Quantum Numbers
- Principal Quantum Number (n) • Angular Momentum Quantum Number (l) • Magnetic Quantum Number (m_l) • electron Spin Quantum Number (m_s)

Atomic Orbitals
- s Orbitals • p Orbitals • d Orbitals and Other Higher-energy Orbitals
- Energies of Orbitals

Electron Configuration
- Energies of Atomic Orbitals in Many-Electron Systems
- The Pauli Exclusion Principle • The Aufbau Principle • Hund's Rule
- General Rules for Writing Electron Configurations

Electron Configurations and the Periodic Table

Chapter 4: Periodic Trends of the Elements

Development of the Periodic Table

The Modern Periodic Table
- Classification of Elements

Effective Nuclear Charge

Periodic Trends in Properties of Atoms
- Atomic Radius • Ionization Energy • Electron Affinity • Metallic Character

Electron Configuration of Ions
- Ions of Main Group Elements • Ions of d-Block Elements

Ionic Radius
- Comparing Ionic Radius with Atomic Radius • Isoelectronic Series

Chapter 5: Ionic and Covalent Compounds

Compounds

Lewis Dot Symbols

Ionic Compounds and Bonding

Naming Ions and Ionic Compounds
- Formulas of Ionic Compounds • Naming Ionic Compounds

Covalent Molecules and Bonding
- Lewis Theory of Bonding • Molecules • Molecular Formulas
- Empirical Formulas

Naming Molecular Compounds
- Specifying Numbers of Atoms • Compounds Containing Hydrogen
- Organic Compounds

Covalent Bonding in Ionic Species
- Polyatomic Ions • Oxoacids • Hydrates
- Familiar Inorganic Compounds

Molecular and Formula Masses

Percent Composition of Compounds

The Mole and Molar Masses

- Determining Molar Mass
- Interconverting Mass, Moles, and Numbers of Particles
- Determination of Empirical Formula and Molecular Formula from Percent Composition

Chapter 6: Representing Molecules

The Octet Rule
- Lewis Structures • Multiple Bonds

Electronegativity and Polarity
- Electronegativity • Dipole Moment, Partial Charges, and Percent Ionic Character

Drawing Lewis Structures

Lewis Structures and Formal Charge

Resonance

Exceptions to the Octet Rule
- Incomplete Octets • Odd Numbers of Electrons • Expanded Octets

Chapter 7: Molecular Geometry and Bonding Theories

Molecular Geometry
- The VSEPR Model • Electron-Domain Geometry and Molecular Geometry
- Deviation from Ideal Bond Angles
- Geometry of Molecules with More than One Central Atom

Molecular Geometry and Polarity

Valence Bond Theory

Hybridization of Atomic Orbitals
- Hybridization of *s* and *p* Orbitals • Hybridization of *s*, *p*, and *d* Orbitals

Hybridization in Molecules Containing Multiple Bonds

Bonding Theories and Descriptions of Molecules with Delocalized Bonding

Chapter 8: Chemical Reactions

Chemical Equations
- Interpreting and Writing Chemical Equations • Balancing Chemical Equations
- Patterns of Chemical Reactivity

Combustion Analysis
- Determination of Empirical Formula

Calculations with Balanced Chemical Equations
- Moles of Reactants and Products • Mass of Reactants and Products

Limiting Reactants
- Determining the Limiting Reactant • Reaction Yield

Chapter 9: Chemical Reactions in Aqueous Solutions

General Properties of Aqueous Solutions

• Electrolytes and Nonelectrolyte • Strong Electrolytes and Weak Electrolytes

Precipitation Reactions

• Solubility Guidelines for Ionic Compounds in Water • Molecular Equations • Ionic Equations • Net Ionic Equations

Acid-Base Reactions

• Strong Acids and Bases • Brønsted Acids and Bases

• Acid-Base Neutralization

Oxidation–Reduction Reactions

• Oxidation Numbers • Oxidation of Metals in Aqueous Solutions

• Balancing Simple Redox Equations • Other Types of Redox Reactions

Concentration of Solutions

• Molarity • Dilution • Solution Stoichiometry

Aqueous Reactions and Chemical Analysis

• Gravimetric Analysis •Acid–Base Titrations

Chapter 10: Thermochemistry

Energy Changes in Chemical Reactions

Introduction to Thermodynamics

• States and State Functions • The First Law of Thermodynamics

• Work and Heat

Enthalpy

• Reactions Carried out at Constant Volume or at Constant Pressure

• Enthalpy and Enthalpy Changes • Thermochemical Equations

Calorimetry

• Specific Heat and Heat Capacity • Constant-Pressure Calorimetry

• Constant-Volume Calorimetry

Hess's Law

Standard Enthalpies of Formation

Bond Enthalpy and the Stability of Covalent Molecules

Lattice Energy and the Stability of Ionic Solids

• The Born-Haber Cycle • Comparison of Ionic and Covalent Compounds

Chapter 11: Gases

Properties of Gases

The Kinetic Molecular Theory of Gases

• Molecular Speed • Diffusion and Effusion

Pressure

• Definition and Units of Gas Pressure

• Calculation of Pressure • Measurement of Pressure

The Gas Laws

• Boyle's Law: The Pressure–Volume Relationship

• Charles's and Gay-Lussac's Law: The Temperature–Volume Relationship

- Avogadro's Law: The Amount–Volume Relationship
- The Gas Laws and Kinetic Molecular Theory • The Combined Gas Law: The Pressure-Temperature-Amount-Volume Relationship

The Ideal Gas Equation

- Deriving the Ideal Gas Equation from the Empirical Gas Laws
- Applications of the Ideal Gas Equation

Real Gases

- Factors That Cause Deviation from Ideal Behavior • The van der Waals Equations • van der Waals Constants

Gas Mixtures

- Dalton's Law of Partial Pressures • Mole Fractions

Reactions with Gaseous Reactants and Products

- Calculating the Required Volume of a Gaseous Reactant
- Determining the Amount of Reactant Consumed Using Change in Pressure
- Predicting the Volume of a Gaseous Product
- Using Partial Pressures to Solve Problems

Chapter 12: Intermolecular Forces and the Physical Properties of Condensed Phases

Intermolecular Forces

- Dipole–Dipole Interactions • Hydrogen Bonding • Dispersion Forces
- Ion–Dipole Interactions

Properties of Liquids

- Surface Tension • Viscosity • Vapor Pressure

Crystal Structure

- Unit Cells • Packing Spheres • Closest Packing

Types of Crystals

- Ionic Crystals • Covalent Crystals • Molecular Crystals • Metallic Crystals

Amorphous Solids

Phase Changes

- Liquid–Vapor Phase Transition • Solid–Liquid Phase Transition
- Solid–Vapor Phase Transition

Phase Diagrams