

SCIENCE

An Introduction to Chemistry

- I. THE STRUCTURE OF MATTER 40%
- A. Atomic Theory and Atomic Structure
1. The Determination of Atomic Masses
 2. Atomic Number, Mass Number, and Isotopes
 - a. The Use of Symbols for Isotopes
 - b. Standard for Atomic Mass $^{12}_6\text{C} = 12.00000$
 - c. Properties and Importance of Commonly Recognized Isotopes— ^2H , ^{14}C , ^{60}Co
 - d. Calculating Weighted Averages
 3. Electron Energy Levels and Emission and Absorption Atomic Spectra
 4. The Wave and Particle Nature of the Electron and Photon
 5. Electron Orbitals
 6. Periodic Relationships—Definitions, General Trends, and Causes
 7. Trends Across a Period of the Periodic Table
 8. Trends Down a Group of the Periodic Table
 9. Electronegativity
- B. Chemical Bonding and Intermolecular Forces
1. Binding Forces
 - a. Intramolecular Forces
 2. Polarity of Bonds
 - a. Intermolecular Forces
 3. The Importance of Hydrogen Bonding in Living Systems
 4. The Effect of Bond Types on the Structures of Solid Compounds
 - a. Ionic Lattice
 - b. Covalent Network or Molecular Solid
 5. How Intermolecular Forces Determine States of Matter (Solid, Liquid, Gas) at Room Temperature
- C. Molecular Models
1. Lewis Structures for Atoms and Covalent and Ionic Compounds
 2. Valence Bond Concept
 3. Hybridization of Atomic Orbitals as an Explanation for Molecular Shapes
 4. The Formation of Molecular Orbitals
 5. Oxidation States
 6. The VSEPR Model
 7. The Resonance Concept Model
 8. The Geometry of Molecules and Ions
 9. Dipole Moments of Molecules
 10. The Relationship between Molecular Properties and Molecular Structure
- D. Nuclear Chemistry
1. Nuclear Equations, Half-lives, and Radioactivity
 - a. Nomenclature for Isotopes (Nuclides)
 - b. Decay Equations and Predicting the Products of Decays

- c. Alpha Bombardment Reactions
 - 2. Fission and Fusion Reactions
- E. Chemistry in the Age of Revolutions: Section I Topics
 - 1. The Scientific Revolution
 - 2. John Dalton's Law of Partial Pressures and Atomic Theory
 - 3. Henry Cavendish and the Discovery of Hydrogen
- II. STATES OF MATTER 25%
 - A. Gases
 - 1. Laws of Ideal Gases
 - 2. Partial Pressures and the Correction of Gas Volumes Collected over Water
 - 3. Kinetic-Molecular Theory (KMT)
 - 4. The Relation of Particle Speed to Mass, Collision Frequency, Volume, and Pressure
 - 5. Avogadro's Law
 - 6. Volume and Mass of One Mole of Ideal Gas at Standard Temperature and Pressure (STP)
 - 7. The Dependence of Kinetic Energy of Molecules on Temperature
 - 8. The Ideal Gas Equation
 - 9. The Behavior of Gases under Extreme Conditions
 - 10. The Dependence of Relative Rates of Diffusion and Effusion on Molecular Mass and Temperature
 - 11. Temperature
 - B. Liquids
 - C. Solids
 - D. Phase Diagrams of One-Component Systems
 - 1. Water and Its Phases and Phase Transitions
 - 2. Carbon Dioxide
 - E. Solutions
 - 1. Types of Solutions and Factors Affecting Solubility
 - 2. Aqueous Solutions
 - 3. Organic (Nonpolar) Solvents
 - 4. Methods of Expressing Concentration
 - a. Percent Composition
 - b. Molarity
 - c. Molality
 - 5. Raoult's Law and Colligative Properties
 - F. Chemistry in the Age of Revolutions: Section II Topics
 - 1. Jacques Charles and Charles' Law
 - 2. Amedeo Avogadro and Avogadro's Law
 - 3. Carl Wilhelm Scheele, Joseph Priestley, Antoine Lavoisier, and the Discovery of Oxygen
 - 4. Joseph Black and the Discovery of Carbon Dioxide
- III. REACTIONS 35%
 - A. Types of Reactions
 - B. Acid-Base Reactions

1. Arrhenius Acids and Bases
2. Brønsted-Lowry Acids and Bases
3. The Acidity Scale: pH
4. Titrations—Mixing Acidic and Basic Solutions to Measure the Concentration of an Unknown
5. Acid-Base Reactions and Salts
- C. Precipitation Reactions
 1. Precipitates
- D. Oxidation-Reduction Reactions
 1. Oxidation Numbers
 2. The Role of the Electron in Oxidation-Reduction
- E. Electrochemistry
 1. Cell Potentials
 2. The Nernst Equation
- F. Stoichiometry
 1. Ionic and Molecular Species Present in Chemical Systems: Net Ionic Equations
 2. Balancing Redox Equations
 3. Mass and Volume Relations
- G. Equilibrium
 1. Chemical Equilibrium
 2. Equilibrium Constants
 3. Quantitative Treatment of Equilibrium
 4. Activity
 5. Equilibrium Constants for Gaseous Reactions: K_p , K_c
 6. Equilibrium Constants for Reactions in Solution
 - a. Constants for Acids and Bases: pK ; pH
 7. Solubility Product Constants and their Application to Precipitation and the 8. Dissolution of Slightly Soluble Compounds
- H. Kinetics
 1. The Concept of Rate of Reaction
 2. The Effect of Temperature, Concentration, and Surface Area Changes on Reaction Rates
 3. Reaction Potential Energy Diagrams, Energy of Activation, and the Role of Catalysts
- I. Thermodynamics
 1. State Functions
 2. The First Law of Thermodynamics
 3. Hess's Law
 4. The Second Law of Thermodynamics
- J. Relationship of Change in Free Energy to Equilibrium Constants and Electrode Potentials
- K. Chemistry in the Age of Revolutions: Section III Topics
 1. Antoine Lavoisier, the Conservation of Mass, and the Birth of Modern Chemistry
 2. Luigi Brugnatelli and the Development of Electroplating
 3. Joseph-Louis Proust and the Law of Definite Proportions
 4. Joseph Black and Latent Heat