

# ChemExplained.com Chapter Outlines

Where the chapters are Taught, Explained and Understood!

\* Words in *italics* are terms, sentences that are underlined are problems.

## CHAPTER 1: An Introduction to Chemistry

- Chemistry: The Central Science (*chemistry*)
- The Stories of Two Chemicals
  - The Ozone Layer (*chemical, ozone, ozone hole*)
  - The Earth's Atmosphere (*troposphere, stratosphere, mesosphere, thermosphere, exosphere*)
  - Ozone Formation (*oxygen gas, radiation*)
  - Chlorofluorocarbons (*chlorofluorocarbons, nontoxic, stable*)
- Chemistry and Matter
  - Matter and its Characteristics (*matter, mass*)
  - Mass and Weight (*weight, atoms*)
  - Branches in the Field of Chemistry
    - Some Branches of Chemistry (*organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, biochemistry, experimental chemistry, industrial chemistry, polymer chemistry, theoretical chemistry, thermochemistry*)
- Scientific Methods (*collaboration*)
  - A Scientific Approach (*scientific method*)
  - Observation (*observations, qualitative data, quantitative data, microscopic, macroscopic, submicroscopic*)
  - Hypothesis (*hypothesis*)
  - Experiments (*experiment, variable, independent variable, dependent variable, control*)
  - Data Analysis and Conclusion (*conclusion, model*)
  - Communication of Results
    - Crushed Ice at Home Experiment
  - Theory (*theory*)
  - Scientific Law (*scientific law*)
- Scientific Research
  - Types of Scientific Investigations (*pure research, applied research*)
  - Students in the Laboratory
  - Laboratory Safety
  - Benefits of Chemistry (*technology*)

## CHAPTER 2: Data Analysis & Scientific Measurement

- Units and Measurement (*metric system, SI system*)
  - SI Units
    - Quantity - Base Unit Chart. (*base unit, second, meter, kilogram, Kelvin, mole, ampere, candela*)
    - Metric Prefix Chart
    - Using Prefixes With SI Units to Solve Metric Bracket Problems
  - Rules for Solving Metric Bracket Problems
    - Metric Bracket Problems
  - Time (*second*)

- Length (*meter, vacuum*)
- Mass (*kilogram, International Prototype Kilogram*)
- Derived Units (*derived unit*)
- Volume (*volume, liter*)
- Density (*density*)
  - Density Problems
  - Using Density and Volume to Solve Mass Problems
  - Using Density and Mass to Solve Volume Problems
- Temperature (*temperature, heat, thermometer, Kelvin*)
  - Temperature Conversion Problems
- Scientific Notation and Dimensional Analysis
  - Scientific Notation (*scientific notation, exponential form, Arrows rule*)
    - Expressing Quantities in Scientific Notation Problems
  - Adding and Subtracting Using Scientific Notation
    - Adding and Subtracting Quantities Written in Scientific Notation Problems
    - Multiplying and Dividing Quantities Written in Scientific Notation Problems
  - Dimensional Analysis (*dimensional analysis, conversion factors, Ristrudt brackets*)
  - Rules For Converting From One Unit to Another
    - Conversion Factor Chart
    - Conversion Factor Problems: Distance, Time, Mass-Weight, Volume (*angstrom*)
    - Multiple Conversion Factor Problems: Density, Velocity, Rates, Volume
- Uncertainty in Data
  - Accuracy and Precision (*accuracy, precision, sucrose*)
  - Percent Error (*experimental values, accepted value, theoretical value, error, percent error*)
    - Percent Error Problems
  - Significant Figures (*significant figures, significant digits*)
  - Rules For Helping Recognize Significant Figures
    - Significant Figure Problems
  - Rounding Off Numbers
  - Rules For Rounding Off Numbers
    - Rounding Off Numbers Problems
  - Rounding Off Rules for Addition, Subtraction, Multiplication, Division
    - Rounding Off Addition, Subtraction, Multiplication, Division Problems
- Representing Data (*graph*)
  - Circle Graphs (*circle graph, pie chart*)
  - Bar Graphs (*bar graph, y-axis, ordinate, x-axis, abscissa*)
  - Line Graphs (*best fit line*)
  - Calculating the Slope of a Line From Data Points (*slope*)
    - Calculating the Slope of a Line From Data Points Problems
  - Interpreting Graphs (*continuous, interpolation, extrapolation*)
    - Making and Using Graphs problem
  - Drawing and Describing Graphs

### CHAPTER 3: Properties and Changes of Matter

- Properties of Matter
  - Substances (*matter, substance*)
  - Physical Properties of Matter (*physical property, luster, malleability, ductility, conductivity, extensive property, intensive property, density, solubility, pores, pyrite*)

- Physical Properties of Common Substances Chart
  - Chemical Properties of Matter (*thermal, chemical property, stability, radioactivity, flammability*)
  - Observing Properties of Matter
  - States of Matter (*states of matter, plasma*)
  - Solids (*solid, incompressible*)
  - Liquids (*liquid, fluid*)
  - Gases (*gas, vapor*)
    - States of Matter Chart
- Changes in Matter
  - Physical Changes (*physical changes, changes of state, melting, freezing, evaporation, condensation, sublimation, deposition*)
  - Chemical Changes (*chemical change, reactants, products, chemical equation*)
  - Conservation of Mass (*law of conservation of mass*)
    - Conservation of Mass Problems
- Mixtures of Matter
  - Mixtures (*mixture*)
  - Types of Mixtures (*heterogeneous mixture, homogeneous mixture, solution, solder, alloy*)
  - Separating Mixtures (*filtration, distillation, crystallization, chromatography*)
- Elements and Compounds
  - Elements (*element, synthesized, symbols*) See: [www.ptable.com](http://www.ptable.com)
  - A First Look at the Periodic Table (*periods, groups, families*)
  - Compounds (*compound, electrolysis, chemical formula*)
  - Law of Definite Proportions (*law of definite proportions, percent by mass*)
    - Law of Definite Proportion Problems
    - Sucrose Analysis from Sugar Beets
    - Sucrose Analysis from Sugar Cane
    - Percent Problems
  - Law of Multiple Proportions (*law of multiple proportions*)
    - Law of Multiple Proportions Problems

## CHAPTER 4: Atomic Structure & Nuclear Reactions

- Early Theories of Matter
  - The Philosophers
  - John Dalton (*Dalton's atomic theory*)
  - Defining the Atom (*atom, scanning tunneling microscope*)
- Subatomic Particles and the Nuclear Atom
  - Discovering the Electron (*ray, cathode, anode, cathode ray, electrons*)
  - The Nuclear Atom (*alpha particles, gold foil experiment, nucleus*)
  - Completing the Atom – The Discovery of Protons and Neutrons (*protons, neutron, subatomic*)
- How Atoms Differ
  - Atomic Number (*atomic number*)
  - Isotopes and Mass Number (*isotopes, protium, deuterium, mass number, isotope notation, symbolic notation*)
    - Atomic Number and Mass Number Problems
    - Composition of Various Isotopes
  - Mass of Individual Atoms (*atomic mass units [amu]*)
    - Calculating Average Atomic Mass Problems

- Unstable Nuclei and Radioactive Decay
  - Radioactivity (*nuclear reactions, radioactivity, radiation, spontaneous, radioactive decay*)
  - Type of Radiation
  - Alpha Radiation (*alpha radiation, nuclear equation*)
  - Beta Radiation (*beta radiation, beta particles*)
  - Gamma Radiation (*gamma radiation, gamma rays*)
    - Nuclear Equation Problems
  - Summary
    - Characteristics of Alpha, Beta, and Gamma Radiation Chart
  - Benefits of Chemistry (*technology*)
  - Students in the Laboratory
  - Laboratory Safety

## CHAPTER 5: Electron Configuration in Atoms

- Light and Quantized Energy
  - The Nuclear Atom and Unanswered Questions
  - Wave Nature of Light (*electromagnetic radiation, electromagnetic spectrum, EM spectrum, crests, troughs, frequency, hertz, cycle, period, amplitude, wavelength*)
  - Particle Nature of Light (*quanta, quantum, joule, Planck's constant*)
    - Information Used To Calculate Planck's Hypothesis Problems
    - Planck's Hypothesis Problems (*newton*)
    - Wavelength of High Speed Particle problem
  - Momentum and Inertia (*inertia, momentum*)
    - Momentum Problems
    - Calculating Wavelength from Momentum problem
  - Direct Variation
  - Inverse Variation
    - If Other Factors Are Held Constant, . . . Increase or Decrease Problems (*Newtonian mechanics, Quantum mechanics, photoelectric effect, photoelectrons, photons*)
  - Atomic Emission Spectra (*atomic emission spectrum*)
  - Summary of Wave Model and Particle Model of Light
- Quantum Theory and the Atom (*quantized*)
  - The Bohr Atomic Model (*ground state, quantum numbers, planetary model*)
  - Louis deBroglie (*deBroglie equation*)
  - Werner Heisenberg (*Heisenberg's Uncertainty Principle*)
  - Irwin Schrodinger (*atomic orbital, electron cloud, quantum numbers, quantum mechanical model of the atom*)
  - The Quantum Mechanical Model
  - The 1<sup>st</sup> Quantum Number, "n" (*principal quantum number*)
    - Calculating Maximum Number of Electrons in Energy Levels problem
    - Energy Level, Quantum Number, Radius by Experiment, Relative Energy Chart
  - The 2<sup>nd</sup> Quantum Number, "l" (*angular momentum quantum number*)
  - The 3<sup>rd</sup> Quantum Number, "m" (*magnetic quantum number, atomic orbital*)
  - The 4<sup>th</sup> Quantum Number, "s" (*spin quantum number*)
- Electron Configurations (*electron configuration, diagonal rule, aufbau principle, aufbau diagram*)
  - Diagonal Rule Chart
  - Electron Configuration Problems (*Hund's Rule*)
  - Using the Periodic Table to Determine Electron Configuration

- Quantum Number Values
- Pauli Exclusion Principle (*degenerate*)
- Noble Gas Configuration (*noble gas configuration*)
  - Noble Gas Configuration problem
- Plotting Points in Space (*abscissa, ordinate*)
- Orbital Diagrams
  - Orbital Shapes Charts
- Valence Electrons (*valence electrons*)
- Electron Dot Diagrams (*electron dot diagram*)
  - Electron Dot Diagram Problems

## CHAPTER 6: The Periodic Law & The Periodic Table

- Development of the Modern Periodic Table (*periodic table, periods, groups, families, periodic law*)
  - History of the Periodic Table's Development (*law of octaves*)
  - The Modern Periodic Table (*periods, group, family, representative elements, transition elements, metals, ductile, malleable, alkali metals, alkaline earth metals, nonmetals, chalcogens, halogens, inert, noble gases, metalloids, coinage metals*)
- Classification of the Elements
- What do These Elements Have in Common?1Chart
  - Valence Electrons (*valence electrons*)
  - The s, p, d, and f – Block Elements
  - The s-Block Elements
  - The p-Block Elements
  - The d-Block Elements (*transition metal*)
  - The f-Block Elements (*inner transition metal*)
    - Noble Gas Configuration and the Periodic Table Problems
    - List all the Symbols of Elements With These Valence Electron Configurations
    - Identify Each of the Following as a Representative Element or Transition Element
- Periodic Trends
  - Atomic Radius (*atomic radius*)
    - Atomic Size Chart
    - Atomic Radius Problems
  - Ionic Radius (*ionic radius*)
    - Ionic Size Chart
    - Ionic Radius Problems
    - Calculating Intermolecular Distance Problems
  - Ionization Energy (*first ionization energy*)
    - First Ionization Energy ( $E_{\text{ion}}$ ) Chart
    - First Ionization Energy Problems
  - Factors That Affect  $E_{\text{ion}}$  for Each Element (*shielding effect*)
  - The Octet Rule (*octet rule*)
    - Group, Valence Electrons, Ionic Charge Chart
    - Octet Rule Problems
  - Electronegativity (*chemical bond, electronegativity*)
    - Electronegativity Chart
    - Electronegativity Problems

## CHAPTER 7: Chemical Formulas, Metals & Alloys

- Forming Chemical Bonds (*compounds*)
  - Chemical Bonds (*chemical bond, ions, valence, cation, anion, ionic compound*)
  - Determining Charges of Ions
  - How Do You Write a Correct Chemical Formula for an Ionic Compound? (*ion, monatomic ion, polyatomic ion, radical, oxidation number, valence*)
    - Writing Correct Chemical Formula Problems
  - How Radicals (Polyatomic Ions) Are Named
  - Naming Chemical Compounds (*chemical nomenclature*)
  - Binary Compounds (*binary compounds*)
  - Binary Acids (*binary acids*)
  - Ternary Compounds (*ternary compounds*)
  - Ternary Acids (*ternary acids*)
  - Diatomic Molecules (*diatomic*)
    - Chemical Formula Problems
    - Naming Chemical Compounds Problems
  - Using of Roman Numerals in Compounds
    - Roman Numeral Problems
  - Use of Greek Prefixes in Compounds
    - Greek Prefixes Problems
  - Hydrates in Compounds (*hydrate, water of hydration, anhydrous*)
- The Formation and Nature of Ionic Bonds (*ionic bond*)
  - Properties of Ionic Compounds and Lattice Energy (*crystal lattice, electrolytes, lattice energy*)
- Names and Formulas for Ionic Compounds (*formula unit, monatomic ions, oxyanions*)
- Metallic Bonds and Properties of Metals (*electron sea model, delocalized electrons, free electrons, metallic bond, malleable, ductile, alloy, substitutional alloy, sterling silver, brass, pewter, stainless steel, interstitial alloy, interstices, carbon steel*)

## CHAPTER 8: Lewis Structures of Covalent Compounds

- The Covalent Bond (*covalent bond, molecule, bonding pairs, single covalent bond, lone pairs, unshared pairs, Lewis structures*)
  - Lewis Structure Problems (*valence*)
  - Bond Types and Covalent Multiple Bonds (*sigma bonds, double covalent bond, triple covalent bond, pi bond*)
    - Lewis Structure Problems 2
  - Bond Length and Strength (*bond length, bond distance, bond dissociation energy, endothermic, exothermic*)
- Naming Molecules Review (*oxyacids, oxyanions, binary acids*)
  - Formulas and Names of Some Covalent Compounds Chart
- Molecular Structures (*structural formula*)
  - Lewis Structures of Polyatomic Ions Problems
  - Resonance Structures (*resonance*)
    - Lewis Resonance Structures
  - Exceptions to the Octet Rule (*coordinate covalent bond*)
- Molecular Shapes
  - VSEPR Model (*Valence Shell Electron Pair Repulsion, hybridization, hybrid orbital*)
  - A Molecule with 2 Atoms (*linear*)
  - A Molecule with 3 Atoms (*bent*)
  - A Molecule with 4 Atoms (*trigonal planar*)

- A Molecule with 5 Atoms (*tetragonal, tetrahedral*)
- A Molecule with 6 Atoms (*trigonal bipyramidal*)
- A Molecule with 7 Atoms (*octahedral*)
- Electronegativity and Polarity
  - Electronegativity Difference and Bond Character (*electronegativity, polar, polar bond, nonpolar covalent, polar covalent, ionic bond, ionic character*)
    - Percent Ionic Character of Single Covalent Bond Chart
    - Electronegativity Problems (*dipole*)
    - Electronegativity and Polarity Problems
    - Polar and Nonpolar Problems
  - Properties of Covalent Compounds (*intermolecular forces, van der Waals forces, dispersion forces, dipole-dipole force, hydrogen bond*)
  - Covalent Network Solids (*covalent network solids*)

## CHAPTER 9: Chemical Reactions & Equations

- Reactions and Equations (*synthetic, chemical reaction, chemical change, equation, reactants, products, aqueous, crystalline, word equations, skeleton equations*)
  - Balancing Chemical Equations (*balanced chemical equation, coefficients*)
    - Balancing Equations Problems
- Classifying Chemical Reactions
  - Synthesis Reactions (*synthesis reaction*)
  - Combustion Reactions (*combustion reaction, hydrocarbon, alkanes*)
  - Decomposition Reactions (*decomposition reaction*)
  - Single Replacement Reactions (*single-replacement reaction*)
  - Double Replacement Reactions (*double-replacement reaction*)
  - Periodic Trends in Reactivity (*activity series*)
    - Predicting Single Replacement Problems
- Reactions in Aqueous Solutions (*substance, solution, solute, solvent, aqueous solution, dissociation reaction*)
  - Dissociation Reaction Problems
  - Reactions That Form Precipitates (*precipitate, complete ionic equation, net ionic equation, spectator ions*)
    - Reactions That Form Precipitate Problems
  - Reactions That Form Water
    - Reactions That Form Water Problems
  - Reactions That Form Gases
    - Reactions That Form Gases Problems
  - The Three Chemicals in Chemistry That Break Down!
    - $\text{H}_2\text{SO}_3$ ,  $\text{H}_2\text{CO}_3$ ,  $\text{NH}_4\text{OH}$

## CHAPTER 10: The Mole Concept

- Formula Mass and Measuring Matter (*atomic mass unit, molecular mass, formula mass, atomic weight, atomic mass, gram-atomic weight, gram molecular weight*)
  - Formula Mass Problems
  - Mass and the Mole
    - Using Molar Mass (*mole, molar mass*)
  - Avogadro's Number (*Avogadro's number, mole, representative particle, specie*)
    - Mass to Moles, Moles to Mass, Avogadro's Number Problems

- Atoms to Moles, Moles to Atoms, Avogadro's Number Problems
  - Conversion From Mass to Moles to Particles Problems
- Percent Composition (*percent composition*)
  - Percent Composition Problems
- Percent Composition of Hydrates
  - Percent Composition of Hydrates Problems
- Empirical Formulas (*empirical formula*)
  - Empirical Formula Problems
- Molecular Formulas (*molecular formula, hydrate, anhydrous*)
  - Molecular Formula/Hydrate Problems (azobenzene)
  - Formulas of Hydrates

## CHAPTER 11: Stoichiometry: How Much?

- What is Stoichiometry? (*stoichiometry*)
  - Mole Ratios (*mole ratio*)
    - Mole Ratio Problems
- Stoichiometric Calculations
  - Mole to Mole Conversion Problems
  - Moles to Mass Conversion Problems
  - Mass to Moles Conversion Problems
  - Mass to Mass Conversion Problems
  - Impure Substances (*inert*)
    - Impure Substance Problems
- Limiting Reactants (*limiting reactant, excess reactant*)
  - Limiting Reactant Problems
  - Percent Yield (*percent yield, theoretical yield, theoretical value, actual yield, experimental value*)
  - Percent Error (*percent error*)
    - Percent Error Problems

## CHAPTER 12: States of Matter & the Kinetic Theory

- Gases (*kinetic-molecular theory, kinetic energy*)
  - Gas Particle Size
  - Gas Particle Motion (*elastic collision*)
  - Gas Particle Energy (*velocity, temperature*)
    - Kinetic Energy Problems (erg)
  - Explaining the Behavior of Gases
  - Low Density Gases (*density*)
  - Compression and Expansion
  - Diffusion (*diffusion*)
  - Graham's Law of Effusion (*effusion, Graham's Law*)
    - Graham's Law Problems
  - Gas Pressure (*pressure*)
  - Measuring Air Pressure (*atmospheric pressure, air pressure, barometer*)
  - Units of Pressure (*pascal*)
    - Pressure Conversion Problems (manometer)
    - Manometer Problems
  - Mean Free Path (*mean free path*)



- Dalton's Law of Partial Pressures
  - Dalton's Law of Partial Pressure Problems
- Forces of Attractions (*intermolecular forces*)
  - Intermolecular Forces
  - Dispersion Forces (*dispersion forces*)
  - Dipole-Dipole Forces (*dipole-dipole forces*)
  - Hydrogen Bonds (*hydrogen bond*)
- Liquids and Solids
  - Liquids
  - Density and Compression
  - Fluidity (*fluidity, fluids*)
  - Viscosity (*viscosity*)
  - Viscosity and Temperature
  - Surface Tension (*surface tension, surfactants*)
  - Capillary Action (*capillary action, meniscus, cohesion, adhesion*)
  - Solids
  - Density of Solids
  - Crystalline Solids (*crystalline solid, crystals, crystal lattice*)
  - Crystal Lattice Shapes (*cubic, tetragonal, orthorhombic, triclinic, hexagonal, rhombohedral, monoclinic, unit cell*)
  - Types of Crystalline Solids and Their Characteristics (*atomic solids, molecular solids, covalent network solids, ionic solids, metallic solids*)
    - Crystalline Solid Problems
  - Amorphous Solids (*amorphous*)
- Phase Changes (*phases*)
  - Phase Changes That Require Energy (*melting point, vaporization, evaporation, boiling point*)
  - Sublimation (*sublimation*)
  - Phase Changes That Release Energy
  - Condensation (*condensation, fog*)
  - Deposition (*frost, deposition*)
  - Freezing
- Phase Diagrams (*phase diagram, triple point*)

## CHAPTER 13: Gas Laws & Stoichiometry

- The Gas Laws (*kinetic theory, ideal gas*)
  - The Nature of Gases (*STP*)
  - Boyle's Law (*Boyle's Law*)
    - Boyle's Law Problems
  - Charles's Law (*Charles's Law*)
    - Charles's Law Problems
  - Gay-Lussac's Law (*Gay-Lussac's Law*)
    - Gay-Lussac's Law Problems
- The Combined Gas Law and Avogadro's Principle
  - The Combined Gas Law (*Combined Gas Law*)
    - Combined Gas Law Problems
  - Avogadro's Principle (*Avogadro's Principle, molar volume*)
    - Stoichiometry: Mass to Volume, Volume to Mass Problems
- The Ideal Gas Law (*ideal gas constant*)

- Ideal Gas Equation Problems
  - Calculating Density From the Ideal Gas Equation Problems
- Dalton's Law (*Dalton's Law, partial pressure*)
- Solving Dalton's Law Problems
- Linear Interpolation
  - Linear Interpolation Problems
  - Dalton's Law Partial Pressure Problems
  - Dalton's Law Problems
- Nonstandard Conditions
  - Nonstandard Condition Problems
- Stoichiometry: Volume to Volume
  - Stoichiometry: Volume to Volume Problems

## CHAPTER 14: Solutions & Concentration

- Densities – Molecular Masses of Two Gases
  - Densities – Molecular Masses of Two Gases Problems
- Risbrudt's Density Law
  - Risbrudt's Density Law Equation Problems
- Calculating Gas Density
  - Gas Density Problems
- What Are Solutions? (*solutions, solute, solvent, soluble, insoluble, miscible, immiscible, solvation, hydration, solubility, saturated solution, unsaturated solution, supersaturated solution*)
  - Solubility – Temperature Graph Problems
- Pressure and Solubility (*Henry's Law*)
  - Henry's Law Problems
- Classifications of Solutions (*concentrated solution, dilute solution, standard solution*)
- Solution Concentration
  - Molarity (*molarity*)
    - Molarity Problems
  - Normality (*normality, equivalent, gram-equivalent weight*)
    - Gram-Equivalent Weight problem
    - Normality Problems
  - Molality (*molality*)
    - Molality Problems
  - Mass Percent (*mass percent, percent by mass, percent concentration*)
    - Mass Percent Problems
  - Mole Fraction (*mole fraction*)
    - Mole Fraction Problems
  - Mole Percent (*mole percent*)
    - Mole Percent problem
  - Volume Percent (*volume percent, percent by volume*)
    - Volume Percent Problems
  - Diluting Molar Solutions (*stock solution*)
    - Diluting Molar Solutions Problems
- Colligative Properties of Solutions (*colligative properties*)
  - Raoult's Law (*vapor pressure, vapor pressure lowering, Raoult's Law*)
    - Raoult's Law Problems
    - Determination of Molecular Weights from Raoult's Law Problems

- Boiling Point Elevation (*boiling point, condensation point, boiling point elevation*)
- Freezing Point Depression (*freezing point, melting point, freezing point depression*)
  - Boiling Point Elevation – Freezing Point Depression Problems
- Boiling Point – Freezing Point Calculations
  - Boiling Point – Freezing Point Calculations Problems
- Molecular Mass Calculations
  - Molecular Mass Calculations Problems
- Osmotic Pressure (*osmosis, osmotic pressure*)
  - Osmotic Pressure Problems
- Making Solutions
  - Making Solutions Problems
- Heterogeneous Mixtures (*suspension, colloid, Brownian movement, Tyndall Effect*)

## CHAPTER 15: Thermochemistry & Enthalpy Change

- Energy (*energy, potential energy, kinetic energy, Law of Conservation of Energy, chemical potential energy, heat, calorie, joule, Calories*)
  - Converting Energy Units Problems
  - Specific Heat (*specific heat capacity, calorimeter*)
    - Specific Heat Capacities of Common Substances at 298K Chart
    - Calculating Heat Problems
  - Thermochemistry (*thermochemistry, molar heat of fusion, heat of melting, molar heat of vaporization, heat of condensation*)
    - Molar Heats of Fusion and Vaporization for Some Substances Chart
    - Thermochemistry Problems
  - Calorimetry (*calorimetry*)
    - Calorimetry Problems
  - Specific Heat Capacity
    - Specific Heat Capacity Problems
- Thermodynamics (*thermodynamics, heat of reaction, enthalpy, heat of formation*)
  - Heat of Reaction
    - Heat of Reaction Problems
  - Mass to Heat Calculations
    - Mass to Heat Calculations Problems
- Reaction Spontaneity (*entropy*)
  - The Entropy of a System Predicted
  - Gibbs Free Energy (*free energy, isothermic, isobaric, spontaneous, exothermic reactions, nonspontaneous, endothermic reactions*)
    - Thermodynamic Problems
    - Gibbs Free Energy Problems

## CHAPTER 16: Chemical Kinetics - Reaction Rates

- A Model for Reaction Rates (*reaction rate*)
  - Average Reaction Rates
    - Average Reaction Rates Problems
  - The Collision Theory (*collision theory, activated complex, transition state*)
  - Activation Energy
- Factors Affecting Reaction Rate (*rate of reaction, Law of Mass Action*)
  - What Affect Does Concentration Have on Reaction Rate? (*concentration*)

- Specific Rate Constant (*specific rate constant, reaction mechanism*)
  - Reaction Rate Explained
  - Reaction Rate Problems
- What Affect Does Nature of Reactants Have on Reaction Rate? (*activated complex, transition state*)
  - Reaction Mechanisms (*complex reaction, rate determining step*)
- What Affect Does Temperature Have on Reaction Rate?
- What Affect Does Pressure Have on Reaction Rate?
- What Affect Does Surface Area Have on Reaction Rate?
- What Affect Does Catalysis Have on Reaction Rate? (*catalyst, homogeneous catalyst, heterogeneous catalyst, inhibitors*)

## CHAPTER 17: Chemical Equilibrium & Solubility Equilibria

- Equilibrium: A State of Dynamic Balance (*reversible reaction, chemical equilibrium, equilibrium constant, law of chemical equilibrium*)
  - Equilibrium Constant Expressions for Homogeneous Equilibria
  - Equilibrium Constant Expressions for Heterogeneous Equilibria (*heterogeneous equilibrium*)
  - Calculating Equilibrium Constants
    - Equilibrium Constant Problems
- Logarithms (*logarithm, characteristic, mantissa*)
  - Rule #1  $\text{Log } AB = \text{Log } A + \text{Log } B$
  - Rule #2  $\text{Log } A/B = \text{Log } A - \text{Log } B$
  - Rule #3  $\text{Log } A^b = b(\text{Log } A)$
  - Rule #4 (*natural logarithms*)
  - Rule #5 (*antilogarithm*)
    - Logarithm and Antilogarithm Problems
    - Chemical Equilibrium Problems
- Arrhenius Equation (*Arrhenius equation*)
  - Arrhenius Equation Problems
- LeChâtelier's Principle (*LeChâtelier's principle*)
  - LeChâtelier's Principle Problems
  - Chemical Equilibrium Using the Quadratic Formula
    - Chemical Equilibrium 2 Problems
  - Optimum Conditions (*optimum conditions*)
  - Formation of a Gas
  - Formation of a Precipitate (*precipitate*)
  - Formation of a Slightly Ionized Substance
- General Equation for Solubility Equilibria
  - The Solubility Product Constant (*solubility product constant*)
    - Solubility Product Constants at 298K Chart
  - Types of Solubility Equilibria Calculations
    - Molar Solubility Problems
    - Calculating the Solubility Product Constant,  $K_{sp}$  Problems
  - Common Ion Effect
    - Common Ion Effect Problems
  - Predicting Precipitates (*ion product,  $Q_{sp}$ , alkali metals, halides, dilution factor*)
    - Predicting Precipitate Problems

## CHAPTER 18: Acid & Base Calculations

- Introduction to Acids and Bases (*formic acid, carbonic acid, citric acid, ascorbic acid, vitamin C*)
  - The pH Scale (*hydronium ion*)
    - Dissociation Reaction Problems
    - pH Problems
- What Are Electrolytes? (*electrolytes*)
  - Properties of Acids (*litmus paper*)
  - Properties of Bases (*hydroxyl, alcohols, ethyl alcohol*)
  - Acid and Base Theories (*Arrhenius theory, Brønsted-Lowry theory, Lewis theory*)
  - Conjugate Acids and Conjugate Bases (*conjugate, conjugate acid, conjugate base, amphoteric*)
    - Conjugate Acid and Conjugate Base questions
  - Anhydrides (*anhydride, acid anhydride, basic anhydride*)
  - Predicting Anhydrides
    - Predicting Anhydride Problems
- Salts (*salt, cation, anion*)
  - Predicting Salt Formations
  - Strengths of Acids and Bases (*strong acid, strong base, weak acid, weak base*)
  - The Ionization Constant (*ionization constant*)
  - Solving Ionization Constant Problems
    - Ionization Constant Problems
  - Percent of Ionization (*percent of ionization, degree of ionization*)
    - Percent of Ionization Problems
  - Polyprotic Ionization (*monoprotic acid, diprotic acid, polyprotic acid*)
  - Polyprotic Reaction Mechanism
    - Polyprotic Ionization Problems
- Titration (*acid-base neutralization, standard solution, buret, indicator, equivalence point, end point*)
  - The Laboratory Titration Procedure
    - Titration Problems

## CHAPTERS 19: Oxidation - Reduction Reactions

- Oxidation and Reduction (*bioluminescence*)
  - Determining Oxidation Numbers (*oxidation number*)
  - Rules for Determining Oxidation Numbers
    - Determining Oxidation Number Problems
  - Oxidation and Reduction (*electronegativity, oxidation-reduction reaction, redox reaction*)
  - Electron Transfer and Redox Reactions (*redox reaction, nonredox reaction*)
    - Write the Balanced Chemical Equation, Complete Ionic Equation, Net Ionic Equation (*oxidation, reduction, mnemonic, half-reaction*)
    - Identifying Oxidation-Reduction Problems.
    - Writing Out Reduction and Oxidation Reaction Problems.
  - Identifying Oxidizing Agents and Reducing Agents (*reducing agent, oxidizing agent*)
    - Identifying Oxidizing Agents and Reducing Agents Problems.
  - Can an Element Ever be Oxidized and Reduced in the Same Reaction?
- Balancing Redox Equations
  - Balancing Redox Equations by Oxidation Number Change (*oxidation number change method, method*)
    - Balancing Redox Equations by Oxidation Number Change Method Problems.
  - Balancing Redox Equations by Using Half-Reactions (*specie*)

- Balancing Redox Equations by Using Half-Reactions Problems.
- Balancing Redox Equations by Using Half-Reactions in Acid Solutions.
  - Balancing Redox Equations by Using Half-Reactions in Acid Solutions Problems.

## CHAPTER 20: Electrochemistry & Cell Potential

- Voltaic Cells (*electrochemistry, electric current, electrochemical cell, electrolytic cell, voltaic cell, half-cells, salt bridge, agar gel, anode, cathode*)
  - Calculating Cell Potential (*reduction potential, standard hydrogen electrode, cell potential*)
    - $E^0_{\text{cell}} = E^0_{\text{reduction}} - E^0_{\text{oxidation}}$
    - Standard Reduction Potentials at 25°C, 1 atm, and 1 M Hydrogen Ion Concentration
  - Rules For Determining Cell Potentials
    - Calculating Cell Potential Problems
    - Voltaic Cell question (cell notation)
    - Standard Cell Potential, Cell Reaction, Cell Notation Problems.