Test 1 Topics - Select Topics from Chapter 1-5

Highlighted topics are optional since they are not vital to the understanding of the concepts being discussed.

- Scientific notation
- Significant figures
- Matter
- Pure substances
- Mixtures
- Homogeneous vs heterogeneous mixtures
- Compounds
- Elements
- Physical properties of matter
- Chemical properties of matter
- States of matter
- Physical changes vs. chemical changes
- Conservation of mass
- Democritus
- Dalton and his atomic theory
- Law of Definite Proportions/Multiple proportions
- Cathode ray tubes and J. J. Thompson’s experiment
- Millikan’s oil drop experiment
- Rutherford’s gold foil experiment
- Alpha particles
- Proton, neutron, electron, nucleus
- Attraction and repulsion of charged particles
- Atomic number
- Mass number
- Number of protons, neutrons, and electrons
- Isotopes and their natural abundance
- Atomic mass unit (amu)
- Atomic mass
- Wave nature of light
- Electromagnetic spectrum
- Wavelength, frequency, and the speed of light \( c = \lambda \nu \)
- Particle nature of light
- Quantum or quanta
- Photon
- Planck’s constant and \( E = h \nu \)
- The Photoelectric Effect
- Atomic emission spectra solar energy/chromophores/photosynthesis
- Bohr Model of the Atom
- Energy states, ground state, excited state
- The energy diagram describing the energy of an electron in the ground state, after it is excited, and after it emits light to fall back to the ground state. \( \Delta E = h \nu \)
- Louis de Broglie’s wave equation \( \lambda = h / (mv) \) describes how all moving particles have wave characteristics
- The Heisenberg Uncertainty Principle *just mention
- The Schrodinger wave equation *just mention
- Atomic orbital
- Principal quantum number \( (n = 1, 2, 3, \ldots) \)
- Energy sublevels \((s, p, d^\ast, f^\ast)\) *Note- you do not have to know the shapes of the starred orbitals
Test 2 Topics - Parts of Chapter 5, 6, 8, 9

- Electron configuration
- Orbital Diagrams
- Aufbau principle
- The Pauli Exclusion Principle
- Hund's Rule
- Valence electrons
- Noble gas configurations
- History of the Periodic Table (minimal questions)
  - Newlands and the “Law of Octaves”
  - Mendeleev and Meyer
    - Ordered by atomic mass and left black spaces that predicted where elements should be before they were discovered.
  - Moseley
    - Re-ordered the table to go by atomic number
- Periodic Table
  - S, p, d, f block
  - Metals, nonmetals, metalloids
  - Alkali metals, alkaline earth metals, halogens, noble gases, transition metals, inner transition metals.
- Periodic Trends
  - Ionization Energy
  - Atomic Radius
  - Ionic Radius
  - Electronegativity
- You must be able to explain why the periodic trends exist:
  - Force of Attraction between valence electrons and the nucleus affected by:
    - Effective nuclear charge which is determined by:
      - Number of shielding electrons
      - Number of protons and electrons in the valence shell
    - Distance of valence electrons from nucleus
- Lewis dot structures of
  - Neutral atoms
  - Ions
  - Ionic compounds
  - Covalent compounds
    - Line structures of covalent compounds as well.
- Ion formation reactions
  - Ionic compound formation reactions
  - Balanced in atoms and charge
- Ionic Bonding characteristics
- Lattice Energy
- Metallic Bonding
- Alloys
- Polyatomic ions
- Binary ionic compounds
- Cations and anions
- Oxidation state/number
- Transition metals have more than one oxidation state
- Naming
  - Ionic compounds
  - Covalent compounds
  - Polyatomic ions
• Must be able to write the formula OR name depending on what is given

• Potential energy
  • Why do bonds form?
  • Bond length

• Exceptions to the Octet rule
  • Be able to recognize that a molecule is an exception
    • Odd number of electrons leading to a free radical
    • Fewer than 8 electrons around an atom
    • Expanded octet

**Test 3 Topics** - Chapter 9, 13.2, 22, 23

• VSEPR
• Electron domain geometries
• Molecular Geometries chirality/biology structure-function (enzymes, proteins)
• Hybridization
• Pi bonds, sigma bonds
• Resonance Structures
• Polarity
• Intermolecular Forces of Attraction
  • Hydrogen bonding
  • Dipole-Dipole interactions
  • London Dispersion Forces

• Organic Chemistry
  • Representations of organic molecules
  • Hydrocarbons (alkanes, alkenes, alkynes, cyclic hydrocarbons)
    • Properties
    • Naming
  • Functional Groups
    • Alkenes, alkynes
    • Alcohols
    • Carboxylic acids
    • Ethers
    • Esters
    • Ketones
    • Amines
    • Benzene/aromatic groups
  • Reactions
    • Combustion reaction- (oxidation reactions)
    • Incomplete Combustion Reaction
    • Addition reactions
    • Substitution reactions
    • Condensation reactions
    • Elimination Reactions
  • Isomers
    • Structural isomers
    • Chirality and optical isomers

**Unit 4 Topics** - Chapter 10, 11, 12

• Chemical Reactions
• Reactants, products
• Balancing reactions
Naming reactants/products
• Synthesis reactions
• Combustion reactions
• Decomposition reactions
• Single replacement reactions
• Activity Series
• Double replacement reactions
• Reading solubility rules charts
• Precipitates
• Complete ionic equations
• Spectator ions
• Net ionic equations
• The Mole
• Avogadro’s Number
• Conversion Factors (m, mm, mL, m, etc.)
• Molar Mass of atoms and compounds
• Empirical formula
• Molecular formula
• Ionic compounds/covalent compounds/isomers
• Percent Composition
• Percent by mass
• Hydrates
• Stoichiometry (food chemistry/ozone & freon)
• Mole ratio
• Limiting reactants
• Excess reactants

Test 5 Topics - Chapter 16, 13

• Types of energy-Kinetic Energy, Chemical potential Energy, Gravitational potential energy
• Units of energy (Calorie, calorie, Joules)
• Temperature- relationship between temperature and kinetic energy, \( KE = \frac{3}{2}kT \)
• Units of temperature (celsius, kelvin)
• Thermodynamics
• Zeroth Law of Thermodynamics
• First Law of Thermodynamics
• Interconversion of different types of energy
• Heat
• Specific heat
• \( q = mc\Delta T \)
• calorimetry
• exothermic
• endothermic
• enthalpy- heat of reaction
• thermochemical equations and stoichiometry
• changes in states of matter
• plot of temperature vs. heat and changes in state
• heat of fusion
• heat of solidification
• heat of condensation
• heat of vaporization
• writing thermochemical equations for phase changes
• Hess’s Law
• Formation reactions
• Standard enthalpy of formation
• Spontaneous vs. nonspontaneous processes
• Entropy (DNA)
• Predicting entropy changes
• Enthalpy
• Law of disorder
• Predicting changes in entropy
• Gibbs free energy (ATP)

Test 6 Topics  - Chapter 13, 14

• Kinetic Molecular Theory
• Average Kinetic Energy, plot of average kinetic energy distribution
• Pressure
• Volume
• Diffusion
• Effusion
• Barometer
• Manometer
• Graham’s Law- Dalton’s Law of Partial Pressure
• Boyle’s Law
• Charles’s Law
• Gay-Lussac’s Law
• Combined Gas Law
• Avogadro’s Principle
• Molar volume
• Ideal Gas Law
• Ideal gases versus real gases
• Gas Stoichiometry
• Solids, liquids, and gases
  • Density
  • Compression
  • Fluidity
• Viscosity
• Surface tension
• Capillary action
• Crystalline solids
  • Molecular solids
  • Covalent network solids
  • Ionic solids
  • Metallic solids
• Amorphous solids
• Phase Changes and energy of phases and phase changes
• Melting
• Vaporization
• Vapor Pressure
• Sublimation
• Condensation
• Deposition
• Freezing
• Phase Diagrams (Triple point video)

Test 7 Topics  - Chapter 15, 17, 18

• Solutions (chemical toxicity)
• Soluble
- Insoluble
- Miscible
- Immiscible
- Solvation (dissolving) of ionic compounds
- Solvation (dissolving) of molecular compounds
- Factors that affect rate of solvation
- Solubility
- Saturated solution
- Unsaturated solution
- Supersaturated solution
- Factors that affect solubility
- Solubility of Gases
- Concentrations
  - Percent by mass
  - Percent by volume
  - Molarity
  - Molality
  - Mole Fraction
- How to make a solution
- Dilutions
- Colligative Properties
- Vapor Pressure Lowering
- Boiling Point Elevation
- Freezing Point Depression
- Reaction Rates
- Collision Theory
- Factors that affect reaction rate and how they affect reaction rate
  - Concentration
  - Temperature
  - Surface Area
  - Catalyst
  - Inhibitor
- Activated Complex/Transition State
- Activation Energy
- Rate Laws
- Rate Constant
- Reaction Order
- Instantaneous reaction rate -
- Rate of a reaction over time (average)
- Complex Reaction
- Reaction Mechanism
- Elementary Step
- Intermediate
- Rate-Determining Step
- Potential Energy Diagram for complex reactions
  - Review enthalpy, activation energy
- Equilibrium
- Reversible reaction
- Equilibrium Expressions
- Equilibrium constant
- Le Chatelier's Principle
  - Concentration
  - Temperature
  - Pressure
  - Catalyst (no effect)
Test 8 Topics - Chapter 18, 19, 16

- Le Chatelier's Principle
  - Concentration
  - Temperature
  - Pressure
  - Catalyst (no effect)
- Keq expressions, finding Keq, finding concentrations when given Keq, Q vs. Keq
- Solubility Equilibria and $K_{sp}$
- Common ion effect
- Molar solubility
- Using $K_{sp}$ to predict solubility and concentration of reactants or products
- Using $K_{sp}$ to solve a common ion problem
- Using $K_{sp}$ to determine if a precipitate will form ($K_{sp}$ vs. $Q_{sp}$)
- Arrhenius model of acids and bases
- Bronsted-Lowry model of acids and bases
- Acidic, basic, and neutral solutions
- Common reactions of acids
- Common reactions of bases
- Conjugate acid-base pairs
- Amphoteric
- Monoprotic and polyprotic
- Strength of acids and bases
- what makes something a stronger or weaker acid?
- How do acids form hydrogen ions in solution?
- $K_a$ and $K_b$
- Equilibrium expressions for acids or bases
- $K_w$
- pH and pOH- acid rain/ ocean acidification
- pH calculations
- neutralization reaction
- acid-base titration
- equivalence point
- endpoint
- salt hydrolysis
- pH/pOH of a weak acid or base
- buffers

Test 9 Topics - Chapter 20, 21, 25

- Oxidation
- Reduction
- Redox reactions
- Oxidation numbers
- Oxidizing agent
- Reducing agent
- Half-reaction
- Balancing redox reactions
- Electrochemistry
- Voltaic cells
- Anode
- Cathode
- Salt bridge
- Reduction potentials
- Cell potential ($E_{cell}$)- connect to potential energy **See Steve
- Battery
- Electric current/stoichiometry ***See Steve
- Electrolysis
- Electroplating
- Nuclear chemistry
- Chemical reactions versus nuclear reactions
- Radioisotope
- Types of radiation
- Strong force
- Electrostatic force
- Band of stability
- Beta decay
- Alpha decay
- Positron emission
- Electron capture
- Gamma emission
- Half-life
- Radiochemical dating
- Radioactive decay series
- Transmutation
- Induced transmutation
- Nuclear fusion
- Nuclear fission