

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 ($n = 1, 2, 3, \dots$)
- Energy sublevels (s, p, d*, f*) *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 \leftrightarrow nm, mL \leftrightarrow 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, $KE = 3/2 kT$
- Units of temperature (celsius, kelvin)
- Thermodynamics
- Zeroeth 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