#### **Detailed Breakdown of Topics in Each Chapter**

#### Chapter 1

- Classification of matter
- Properties of matter
- Units of measurement
- Uncertainty in measurement
- Dimensional analysis

### Chapter 2

- Discovery of atomic structure
- Isotopes
- Information in the periodic table
- Molecular vs. empirical formulas (what subscripts mean)
- Predicting monatomic ionic charges
- Determining ionic formulas
- Naming ionic compounds
- Naming binary nonmetal compounds
- Naming acids
- Some other simple organic compounds (alkanes)

# Chapter 3

- The meaning of chemical equations (coefficients, subscripts)
- Using conservation of matter to balance chemical equations
- Recognizing combination, decombination & combustion rxns
- Calculating formula & molecular wts
- Percent composition from formulas
- Conversions using Avogadro's #
- Converting between two measures of quantity of matter: masses and moles
- Determining empirical formula from chemical analysis
- Stoichiometry calculations
- Limiting reactants
- Theoretical vs. actual yield in a chemical reaction

## Chapter 4

- What a solution is (solvent + solute)
- Strong vs. weak electrolytes
- Solubility guidelines for determining how soluble various ionic compounds are in water
- Figuring out the products of an exchange rxn
- Writing net ionic equations for precipitation rxns
- Strengths of acids and bases, and the pH scale
- Writing net ionic equations for acid-base rxns
- Acid-base rxns where one of the products is a gas or dissociates to form a gas
- Oxidation numbers and recognizing redox rxns
- Writing net ionic equations for redox rxns
- Using the metal activity series to predict whether a redox rxn will occur spontaneously
- Calculating concentration of a solution as molarity
- Determining the concentration of one electrolyte in a solution
- Dilution
- Stoichiometry calculations of aqueous rxns (e.g., titration)

## Chapter 5

- Kinetic vs. potential energy at the molecular level, and what happens to these kinds of energy when heat energy is added to or released by molecules
- Work and heat energy meanings
- Heat energy dimensional analysis
  with moles
- Total internal energy (*E*) = sum of KE
  + PE of molecules
- Change of *E* when a change happens to a system (Δ*E*) = q + w
- System vs. surroundings
- Endothermic vs. exothermic processes refers to *q* only
- ∆H = q / (moles of chemical of interest in the system), when the change to the system occurs at constant pressure
- Properties of state functions (such as *H*)
- Using the technique of calorimetry and the equation *q* = *mC*Δ*T* to calculate Δ*H* for rxns
- Calculating  $\Delta H$  for an overall using Hess's law (a consequence of Hbeing a state function): summing  $\Delta H$ values for intermediate rxns that sum to the overall rxn
- Writing formation rxns for compounds
- "Products minus reactants" equation as a special case of Hess's law when all the intermediate rxns are formation rxns

Chapter 6

- Wave nature of light: wavelength, frequency and speed of light, and using  $c = \lambda v$  in calculations
- Particle nature of light: energy & frequency of a photon, and using  $E = h_V$  in calculations
- Atomic emission spectra as evidence for quantization of electron energy levels
- Bohr model for hydrogen, using Rydberg equation to calculate emitted photon energy for specific energy level  $n_{\text{initial}} \rightarrow n_{\text{final}}$  transitions
- Energy sublevels (*l* values), specific orbitals within each energy sublevel (*m<sub>l</sub>* values), and 3-dimensional shapes of the electron density distribution in those orbitals
- Ground state vs. excited states
- Ground state electron configurations in multi-electron atoms, and how it explains the organization of the periodic table
- Writing ground state (and excited state) electron configurations in multiple ways: starting from  $1s^2 2s^2 \dots$ , using noble gas core, writing just the valence part
- Prediction of paramagnetism from electron configuration

### Chapter 7

- Valence vs. core, and effective nuclear charge (Z<sub>eff</sub> = Z S) seen by valence electrons as a useful model to explain some general trends across periods
- Physical properties of atoms: (1<sup>st</sup>) ionization energy, atomic radius, electron affinity (also an energy amount)
- Physical properties of ions: ionic radius, 2<sup>nd</sup> ionization energy
- Isoelectronic atoms and series
- Explaining periodic trends and group trends in physical properties of atoms using Coulomb's law (with Z<sub>eff</sub> or *r* comparisons)
- Metallic character (more like a metal) vs. nonmetallic character

# Chapter 8

- Lattice energy in ionic compounds and comparisons/trends as one ion is varied in ionic formulas, explanations using Coulomb's law
- Basic Lewis structures (for central atoms with octets)
- Relation between bond order, bond strength and bond length
- Electronegativity model for determining the ionic character (polarity) of a covalent bond
- Resonance structures, predicting bond order if all resonance structures are equal, and formal charge model for determining whether one resonance structure contributes more to the actual structure
- Estimating △*H* for a reaction by bonds broken minus bonds formed

# Chapter 9

- Molecular shapes of simple molecules with a central atom
- Underlying electron domain geometry of each shape
- Bond angles, and where VSEPR predicts slight alterations
- Summing bond polarities in a molecule to determine whether the whole molecule is polar
- Valence bond theory: how atomic orbitals hybridize before forming bonds
- σ and π type bonds that form from overlap of atomic/hybrid orbitals on the two atoms that are bonded, and the geometries/shapes of the σ and π orbitals
- Predicting bond angles from knowing the hybridization of orbitals on the atom at the angle's vertex
- Molecular orbital theory: bonding vs. antibonding, and  $\sigma$  vs.  $\pi$  molecular orbitals that are created by combining all of the atomic orbitals in a molecule
- Electron configurations of molecules using MO theory, and predicting bond order and paramagnetism