Ch 7 - Stoichiometry

- balancing chemical equations
- combustion reactions
- stoichiometry calculations - Stoichiometric coefficients and ratios
- percent composition
- determining empirical formula from %composition
- empirical formula from a combustion analysis
- molecular formulas from empirical formulas knowing molecular weight
- limiting reagents
- theoretical, actual, and percent yields

Ch 8: Aqueous Solutions

- Molarity calculations
- Dilution Equation
- Definition of an electrolyte - strong, weak, and non-electrolytes
- Memorize the six strong acids
- Bronsted definition of acids/bases; amphiprotic substances
- Hydronium ion
- Double Displacement Mechanism
- Acid-Base Neutralization Reactions
- Molecular versus Ionic equations, spectator ions, Net Ionic Equation
- Net ionic equation for any strong acid-strong base reaction
- Precipitation Reactions
- Solubility Rules
- Net ionic equation precipitation reaction
- Calculating the mass of a precipitate
- Oxidation-Reduction (Redox) reactions
- Definition of oxidation and reduction
- Oxidizing and reducing agents
- Oxidation Number Rules
- For a given chemical reaction, identify the species oxidized and reduced by assigning oxidation numbers
- Writing half reactions
- Balancing redox reactions in acid or base by the method of half reactions
- titrations

Ch 9 – Thermochemistry

- Energy, work and heat
- Definitions of Potential and Kinetic Energy (don't memorize equations)
- Law of Conservation of Energy
- Units of heat energy: SI units = Joules, English units = calories
- Thermochemistry, heat, system, surroundings
- Open, closed, and isolated systems
- Thermodynamics – state and state functions
- First Law of Thermodynamics $\Delta E = q + w$ (know equation)
- P-V work calculations like Sample Exercise 9.2
- Enthalpy $\Delta H = q_p$ (heat flow under constant pressure – know definition)
- Exothermic versus endothermic
- Heat capacity $C_p$, and specific heat capacity, $c_p$ (note capital C versus lower case c)
- Heat flow calculations using $q = s \cdot m \cdot \Delta T$ (within a phase) and $q = n \Delta H$ (across a phase boundary)
- Heating curve calculations
Calorimetry –

 constant volume (bomb) calorimetry: \( q = -C_p \Delta T \)
 constant pressure (“coffee cup” calorimetry in lab): \( q_{\text{rxn}} = -[m C_p \Delta T + C_p \Delta T] \)

 Hess’ Law Calculations
 Useful calculation techniques: (1) reverse equations, (2) multiplying by a factor \( n \), (3) always specify phases
 Definition of the Standard Enthalpy of Formation, \( \Delta H^o_f \)
 Using \( \Delta H^o_{\text{rxn}} = \sum n_p \Delta H^o_f(\text{products}) - \sum n_r \Delta H^o_f(\text{reactants}) \)
 Heats of reaction and Bond Energies

Ch 10 – Properties of Gases: The Air We Breathe

 Properties of gases – indefinite shape and volume, compressible, mix together evenly and completely, low densities (g/L)
 Kinetic Molecular Theory: \( <\text{KE}> \propto T \), molecular speeds as a function of temperature and molar mass
 Pressure = force/area, units: atm, mmHg (Torr), Pa; converting between units
 Mercury barometer

 Simple Gas Laws: Boyle’s Law: \( P \propto 1/V \) (T and \( n \) constant)
 Charles’ Law: \( V \propto T \) (P and \( n \) constant)
 Avogadro’s Law: \( V \propto n \) (P and T constant)
 Amondson’s Law: \( P \propto T \) (n and V constant)

 Combined Gas Law: \( P_1 V_1/T_1 = P_2 V_2/T_2 \)
 Ideal Gas Law: \( PV = nRT \)

 Deriving simple gas laws from Ideal Gas Law: Boyle’s \( P_1 V_1 = P_2 V_2 \)
 Charles’ \( V_1/T_1 = V_2/T_2 \)
 Avogadro’s \( V_1/n_1 = V_2/n_2 \)
 Amondson’s \( P_1/T_1 = P_2/T_2 \)

 STP: standard temperature and pressure = 1 atm and 273K; 1 mole of any gas occupies 22.4 L @ STP

 Situations where many variables change simultaneously: \( P_1 V_1/n_1 T_1 = P_2 V_2/n_2 T_2 \)

 Calculating densities and molecular weights from the Ideal Gas Law: \( d = PM/RT \), rearranging then \( M = dRT/P \)

 Gases in chemical reactions

 Dalton’s Law of Partial Pressures: \( P_{\text{total}} = P_A + P_B + P_C + \ldots \) where \( P_A \) = partial pressure gas A, etc; and \( P_A = \chi_A P_{\text{total}} \) where \( \chi_A \) = mole fraction of gas A, etc

 Collecting a gas over water: \( P_{\text{total}} = P_{\text{gas}} + P_{\text{H}_2\text{O}} \)

 Solubilities of gases and Henry’s Law

 Graham’s Law of Effusion and Diffusion
Ch 11: Properties of Solutions: Their Concentrations and Colligative Properties

From the first part of the chapter -

- Born-Haber Cycles
- Vapor pressure – effect of intermolecular forces, normal boiling point
- The Clausius-Clapyron equation
- Raoult’s Law - Solutions of volatile compounds
- Deviations from Raoult’s Law
- Colligative Properties – molality, boiling point elevation and freezing point depression, molecular weights, Van’t Hoff factor

Ch 12: Thermodynamics: Why Chemical Reactions Happen

- Spontaneous processes
- Entropy and the 2nd and 3rd Laws of thermodynamics
- Processes where entropy is expected to increase: solid – liquid – gas, dissolving a solute in a solvent, increasing the temperature
- $\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr} > 0$ REMEMBER
- $\Delta S_{surr} = -\Delta H_{sys}/T$ REMEMBER
- $\Delta S_{rxn} = \sum n\Delta H_{prod} - \sum n\Delta H_{react}$