CHEM 116 Topics from Zumdahl

Appendix A1, A2 Chapter 1 - Matter and Measurement

SI units; prefixes

significant figures in calculations: rules for +/- and ×/÷

precision, accuracy; uncertainty (standard deviation)

Chapter 2 - Atoms, Molecules, and Ions; Periodicity; Nomenclature

Lavoisier - conservation of mass

Proust/Dalton - law of definite and multiple proportions (ratios)

Dalton's atomic theory

Gay-Lussac - ratio of reacting gases

Avogadro's hypothesis

building block of the atom - electron, proton, neutron - quarks! (Thomson, Millikan, Rutherford, Chadwick)

nomenclature - ions, compounds, including acids

Chapter 3 - Stoichiometry

relative atomic masses - isotopes and natural abundance

moles and Avogadro's number

determining empirical chemical formulas

1. % composition
2. mass data
3. chemical analysis (*e.g.*, combustion)

balancing chemical equations - including algebraic method

stoichiometry

1. limiting reactant
2. theoretical yield, actual yield, % yield

Chapter 4 - Chemical Reactions, Solution Stoichiometry

types of chemical reactions and ability to properly write each

1. dissolution - solute/solvent interactions
2. precipitation - net ionic equation
3. acid / base - strong acids/bases, anhydrides, characteristic reactions of strong acids and strong bases
3. oxidation / reduction and how to balance by half-reaction method

solutions (molarity, mass %, density)

1. stoichiometry problems with molarity
2. mixing or diluting solutions
4. titrating solutions

Chapter 13 - Bonding Concepts, Lewis Structures

types of chemical bonds: ionic, covalent, polar covalent

periodic trends: ionization energy, electron affinity, electronegativity, ionic size

Lewis structures

1. formal charges
2. resonance structures
3. valence shell expansion

VSEPR - **V**alence **S**hell **E**lectron **P**air **R**pulsion

1. electronic geometry
2. molecular geometry (shape)

dipole moment - molecular polarity

Chapter 5 - Gases

$PV = nRT$ from Boyles Law, Charles Law, and Avogadro's hypothesis

1. density and molar mass
2. stoichiometry
3. Dalton's Law of partial pressures

kinetic-molecular theory of gases - Boltzmann, Maxwell, Clausius

1. T is a measure of average kinetic energy of molecules
2. u_{rms}, $< u >$, u_{mp}
3. Maxwell-Boltzmann distribution law of molecular speeds
4. Graham's law of effusion

collisions - (density) × (cross-sectional area) × (relative speed)

1. Z - collision frequency
2. λ - mean free path

real gases

1. attractive and repulsive forces
2. van der Waals equation of state
3. phase transition - gases condense

Chapter 16 - Intermolecular Forces, Vapor Pressure, Phase Diagrams

types of forces between species

1. ion/ion
2. ion/dipole
3. ion/induced dipole
4. dipole/dipole (includes hydrogen bonding)
5. dipole/induced dipole
6. induced dipole/induced dipole (London dispersion)

phase transitions

simple phase diagrams: triple point, critical point, phase boundaries

Chapter 17 - Properties of Solutions, Colligative Properties

composition - mass %, mole fraction molarity, molality

colligative properties - van't Hoff *i* factor

1. vapor pressure lowering - Raoult's law
2. boiling point elevation
3. freezing point depression
4. osmotic pressure - $\pi = iMRT$

Chapter 6 - Chemical Equilibrium

equilibrium constant K, reaction quotient Q

1. K or K_c - equilibrium constant in terms of concentration
2. K_p - equilibrium constant in terms of equilibrium partial pressures

solving equilibrium problems

Le Châtelier's principle

Chapter 7 - Acids and Bases

1. strong acids and bases, weak acids and bases, and their associated calculations
2. acids and bases: Arrhenius (strong acids, bases), Brønsted-Lowry
3. conjugate acid/base pairs
4. autoionization of water, K_w
5. exact (systematic treatment of equilibrium)
   a) charge balance (if pH is not fixed)
   b) mass balance(s)
   c) equilibrium equations and the corresponding equilibrium constant expressions

FOLLOWING MATERIAL BEST OBTAINED FROM HARRIS TEXT

Chapter 8 - Buffers, Titrations and pH Curves, Polyprotic Acids

buffers - weak acid/conjugate base or weak base/conjugate acid

1. how to prepare
2. addition of strong acid/base to a weak base/acid
3. be able to use the Henderson-Hasselbalch equation

titration of strong acids and strong bases, weak acids and weak bases, and polyprotic acids and polybasic bases

1. before the titration begins
2. before the equivalence point
   a) buffer region (weak acids and weak bases)
   b) half equivalence point (weak acids and weak bases)
3. at the equivalence point
4. beyond the equivalence point

polyprotic acids and polybasic bases

1. systematic treatment of polyprotic weak acids and polybasic weak bases
2. relation of K_a and K_b for polyprotic systems
3. finding the pH
   a) acidic form
   b) intermediate form: $\text{pH} = \frac{1}{2}(\text{p}K_1 + \text{p}K_2)$ - often valid
   c) basic form
4. principal species
5. fractional composition (alpha, α) plots