Study Guide for Final Exam (Ch. 1-11, 13)

Chem1A, General Chemistry I

MEMORIZE:

- Metric Handout: 10 metric prefixes (G, M, k, d, c, m, μ, n, p, f), conversions
- K = °C + 273.15
- density = mass/volume
- 1 in.= 2.54 cm ; 1 mL = 1 cm^3
- Mass number (A) = # of protons + # of neutrons
- atomic mass = ∑ (natural abundance of isotope)(isotopic mass)
- Diatomic elements: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2
- Nomenclature Handout: group charges (Ag^+, Zn^{2+}, Al^{3+}, N^{3-}), polyatomic ions, molecular prefixes, naming conventions for ionic and molecular compounds and acids
- Combustion reactions: hydrocarbon ($C_xH_yO_z$) (g) + O_2(g) → CO_2(g) + H_2O(g)
- Percent Composition: (mass of component/total mass of mixture) x 100%
- Avogadro's Number: 6.022×10^{23} units = 1 mole (mol)
- Percent Yield = (actual yield/theoretical yield) x 100%
- Dilutions: $M_1V_1 = M_2V_2$
- Acid-Base Neutralizations: acid + base → water + salt
- 1 atm = 760 mmHg = 760 torr
- Gas Laws: Boyle's, Charles's, Avogadro's, Ideal, Dalton's Law (both versions)
- R = 0.08206 L·atm/(mol·K)
- Mole Fraction (X_A) = (mols component A)/(total mols mixture)
- ΔE (U) = q + w ; q = m C_s ΔT ; w = $-P_{ext}$ ΔV
- Hess's Law: $\Delta H_{rxn} = \Delta H_1 + \Delta H_2 + \Delta H_3 + \ldots \Delta H_n$
- Enthalpies of Formation: $\Delta H_{rxn} = \Sigma$ n ΔH_f^o (products) – Σ m ΔH_f^o (reactants)
- E = hν, c = λν (h = 6.626×10^{-34} J·s, c = 3.00×10^8 m/s)
- $1/\lambda = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$
- λ = h/(m v)
- Electron Configuration Order (1s 2s 2p 3s 3p 4s 3d 4p, etc…)
- Periodic Trends (Z_{eff}, Atomic/Ionic Radii, Ionization Energy, Electron Affinity)
- nonpolar (perfect) covalent: 0.0-0.4, polar covalent: 0.5-2.0, ionic: 2.1+
- ΔH_{rxn} = Σ (bond enthalpies of bonds broken) – Σ (bond enthalpies of bonds formed)
- VSEPR Geometries (Electronic and Molecular) – handout
- Hybridization (sp, sp^2, sp^3, sp^3d, sp^3d^2)
- Molecular Orbital Diagrams up to period 2 diatomics (order of MOs, types of overlap)
- mass percent = $\frac{\text{g solute}}{\text{total g solution}} \times 100\%$
- Molarity (M) = $\frac{\text{mols solute}}{\text{L solution}}$
- Molality (m) = $\frac{\text{mols solute}}{\text{kg solvent}}$
- Raoult's Law: $P_A = X_A * P°_A$
- Boiling Point Elevation: $\Delta T_b = K_b m$; Freezing Point Depression: $\Delta T_f = K_f m$

Chapter 1: Matter and Measurement

I. Classifications of Matter (1.2): Know how to classify matter as a pure element, pure compound, homogeneous mixture, or heterogeneous mixture based on its composition.

II. Units of Measurement (1.4): Know the common metric prefixes and how to interconvert units with them. Know the conversion between the Kelvin and Celsius temperature scales. Know the general equation for density and how to use it to convert between density, mass, and/or volume.

III. Significant Figures (1.5): Know how to determine the number of significant figures and round appropriately. Know how to round to proper significant figures in calculations.

IV. Dimensional Analysis (1.6): Know how to use dimensional analysis to convert between units in multistep problems, particularly word problems.

Chapter 2: Atoms, Molecules, and Ions

I. Atomic Structure (2.3): Know how to write proper atomic notation for any atom given its makeup, or use atomic notation to determine an atom's subatomic particle composition.

II. Atomic Weights (2.4): Know how to use the equation for an element's atomic weight to determine atomic mass, natural abundance, and/or isotopic mass.

III. Periodic Table (2.5): Know how to use an element's location on the periodic table to determine its group, period, metallic character, main group element vs. transition metal, etc.

IV. Nomenclature (2.7-2.8): Know how to balance and/or name any ionic or molecular compound, including acids. Know the metals with predictable charges and the common polyatomic ions.

Chapter 3: Stoichiometry

I. Balancing Chemical Equations (3.1-3.2): Know how to balance and classify any chemical equation as combination/synthesis, decomposition, or combustion.

II. Molar Mass and Percent Composition (3.3-3.4): Know how to calculate the molar mass for any compound. Know how to determine the elemental percent composition from the chemical formula. Know how to convert between grams, moles, and molecules/atoms for any compound.

III. Empirical and Molecular Formulas (3.5): Know how to determine the empirical or molecular formulas of compounds from decomposition, percent composition, or combustion analysis.

IV. Stoichiometry, Limiting Reactants and Percent Yields (3.6-3.7): Know how to do stoichiometric calculations. Know how to determine the limiting reactant and/or theoretical yield for a reaction, given two or more different reactant amounts. Know how to use the percent yield equation to determine percent yield, theoretical yield, and/or actual yield.

Chapter 4: Aqueous Reactions and Solution Stoichiometry

I. Types of Chemical Reactions (4.2-4.4): Know how to classify reactions as precipitation, acid-base neutralization, gas evolution, or oxidation-reduction (redox) reactions. Know how to predict the

products after a double displacement reaction and, using the solubility guidelines, determine their phases. Know how to write the molecular, total (complete) ionic, and net ionic equations. Know how assign oxidation states and to distinguish elements being oxidized and elements being reduced.

II. Concentration and Solution Stoichiometry (4.5-4.6): Know how to calculate the concentration in molarity (M) for any solution. Know how to use solutions' concentrations and volumes in stoichiometry.

Chapter 10: Gases

I. Gas Laws (10.3-10.5): Know how to use the Gas Laws (Boyle's, Charles', Avogadro's, and the Ideal Gas Law) to calculate any P, V, n or T. Know how to use the Ideal Gas Law in stoichiometric calculations or to calculate the molar mass.

II. Dalton's Law and Mixtures of Gases (10.6): Know how to use Dalton's Law (both versions) for mixtures of gases. Know how to correct pressures of gases collected over water for vapor pressure.

III. Kinetic Molecular Theory, Root Mean Square Speed, and Graham's Law (10.7-10.9): Know how to use the equation for root mean square speed and Graham's Law to compare the speeds of gases and rates of effusion, respectively, to their molar masses.

Chapter 5: Thermochemistry

I. First Law of Thermodynamics (5.2): Know how to calculate ΔE (U) for a system given q and w.

II. Enthalpy (5.3-5.4): Know how to manipulate ΔH_{rxn} (reversing reactions, changing amount, etc., for Hess's Law). Know how to use ΔH_{rxn} as a conversion factor between amount and energy change.

III. Calorimetry (5.5): Know how to perform calculations for constant-pressure (coffee cup) or bomb calorimetry.

IV. Hess's Law and Enthalpies of Formation (5.6-5.7): Know how to use either Hess's Law for a set of reactions or the enthalpies of formation for constituent compounds to calculate ΔH for a reaction.

Chapter 6: Electronic Structure of Atoms

I. Wavelength, Frequency, and Energy (6.1-6.2, 6.4): Know how to convert between the wavelength, frequency, and energy, or threshold energy for electrons for photons. Know how to convert between wavelength emitted, mass, and velocity for any object using the de Broglie Equation.

II. The Hydrogen Atom (6.3): Know how to use the Rydberg Equation to solve for the energy emitted or absorbed when electrons exchange levels in a hydrogen atom.

III. Atomic Orbitals and Electron Configuration (6.5-6.9): Know how to translate four quantum numbers to electrons in atoms. Know how to write the electron configuration for any element on the periodic table. Know how to differentiate between core and valence electrons.

Chapter 7: Periodic Properties of the Elements

I. Periodic Trends (7.2-7.5): Know how to use an element's location on the periodic table to predict and explain its effective nuclear charge, atomic and ionic radius, ionization energy, and electron affinity.

Chapter 8: Concepts of Chemical Bonding

I. Covalent Bonding (8.3-8.7): Know how to draw the correct Lewis structure, including formal charges, possible resonance or exceptions to the octet rule, and dipole moments for any covalent compound.

II. Bond Enthalpies (8.8): Know how to use the Lewis structures and bond enthalpies of compounds in a reaction to calculate the enthalpy.

Chapter 9: Molecular Geometries and Bonding Theories

I. VSEPR Theory (9.1-9.3): Know how to predict the electronic and molecular geometries for molecules given the Lewis structure. Know how to determine whether the molecule is overall polar or nonpolar given electronegativity values.

II. Hybridization (9.4-9.6): Know how to determine the hybridization around the central atom in a molecule from the electronic geometry. Know how to determine the type of orbital overlap (σ or π) composing the molecule's bonds.

III. Molecular Orbital Theory (9.7-9.8): Know how to write and fill molecular orbital diagrams for any homonuclear diatomics up through period 2. Know how to calculate the bond order and determine whether a molecule is paramagnetic or diamagnetic.

Chapter 11: Intermolecular Forces, Liquids, and Solids

I. Intermolecular Forces (11.2): Know how to determine the intermolecular forces present in a molecule given the structure and how it will relate to boiling and melting points, viscosity, surface tension, etc.

II. Heating Curves (11.4): Know how to use the heating curves and ΔH values for phase changes (vaporization, fusion) to calculate the heat/temperature change for a substance or the transfer of heat between two substances.

Chapter 13: Properties of Solutions

I. Concentration (13.4): Know how to calculate a solution's concentration in mass percent, mole fraction, molarity, or molality.

II. Raoult's Law (13.5): Know how to use Raoult's Law and Dalton's Law in combination to calculate the vapor pressure of volatile liquids over a solution or the mole fraction composition of the vapor over a mixture.

III. Freezing Point and Boiling Point (13.5): Know how to use the freezing point depression and boiling point elevation equations to calculate the changes in freezing point/boiling point for mixtures. Know how to use the equations to solve for the molar mass of an unknown.