Final Exam (NOTES)

Chapter 1: The Chemical World

Matter and Molecules:

- Chemistry is the science that tries to understand what matter does by understanding what molecules do.

The Scientific Method:

- Chemists employ the scientific method, which makes use of observation, hypothesis, laws, theories, and experiments.

Law of Conservation of Mass

Atomic Theory

Chapter 3: Matter and Energy

Matter: Matter is anything that occupies space and has mass. Matter can exist as a solid, liquid, or gas. Solid matter can be either amorphous or crystalline.

Classification of Matter: Pure matter is either an element (a substance that cannot be decomposed into simpler substances) or a compound (a substance composed of two or more elements in fixed definite proportions).

Mixtures: two or more different substances, the proportions of which may vary from one sample to the next.

Homogeneous Mixture- Having the same composition throughout

Heterogeneous Mixture- Having a composition that varies from region to region

Properties and Changes of Matter:

- The physical properties of matter do not involve a change in composition
- The chemical properties of matter involve a change in composition
- In a physical change, the appearance of matter may change, but its composition does not
- In a chemical change, the composition of matter does change.

Conservation of Mass: Matter is always conserved. In a chemical change, the sum of the masses of the reactants must equal the sum of the masses of the products.

Energy: Energy is conserved—it can be neither created nor destroyed. Units of energy are the joule (J), the calorie (cal), the nutritional Calorie (Cal), and the kilowatt-hour (kWh).

- Chemical reactions that emit energy are exothermic; those that absorb energy are endothermic.

Temperature: The temperature of matter is related to the random motions of the molecules and atoms. Temperature is measured in three scales: Fahrenheit (°F), Celsius (°C),and Kelvin (K).

Heat Capacity: The temperature change that matter undergoes upon absorption of heat is related to the heat capacity of the substance composing the matter.

Chapter 4: Atoms and Elements

Ions:

- When an atoms gains or loses electrons, it becomes an ion
- Positively charged ions are called cations (metals)
- Negatively charged ions are called cations (nonmetals)
- Cations and anions occur together so that matter is charge neutral (ionic compounds)

Isotopes:

- Atoms of the same element with different number of neutrons are called isotopes
- Isotopes are characterized by their mass number (A), the sum of the protons and the neutrons in the nucleus
- Each naturally occurring sample of most elements has the same percent natural abundance of each isotope
- The atomic mass of an element is a weighted average of the masses of the individual isotopes

Chapter 5: Molecules and Compounds

Chemical Principles:

- **Compounds** display constant composition. The elements that compose a particular compound are in fixed, definite proportions in all samples of the compound.
- **Chemical formulas** indicate the elements present in the compound and the relative number of atoms of each. These formulas represent the basic units that compose a compound.
- **Chemical nomenclature (naming)** the names of simple ionic compounds, molecular compounds, and acids can all be written by examining their chemical formulas
- **Formula Mass** of a compound is the sum of the atomic masses of all atoms in the chemical formula for the compound.

Chapter 6: Chemical Composition

The Mole Concept:

- The mole is a specific number (6.022×10^{23}) that allows us to easily count atoms or molecules by weighing them.
- One mole of any element has a mass equivalent to its atomic mass in grams
- One mole of any compound has a mass equivalent to its formula mass in grams
- The mass of one mol of an element or compound is its molar mass

Chemical Formulas and Chemical Composition:

- Chemical formulas indicate the relative number of each kind of element in a compound
- These numbers are based on atoms or moles
- By using molar masses, the information in a chemical formula can be used to determine the relative masses of each kind of element in a compound
- The total masses of a sample of a compound can be related to the masses of the constituent elements contained in the compound.

Chapter 7: Chemical Reactions

- Chemical Reactions: one or more substances either elements or compounds change into a different substance.
- Evidence of a Chemical Reaction: the only absolute evidence for a chemical reaction is chemical analysis showing that one or more substances have changed into another substance.
- However, one or more of the following often accompanies a chemical reaction: a color change; the formation of a solid or precipitate; the formation of a gas; the emission of light; and the emission or absorption of heat.
- Chemical Equations: chemical equations must be balanced to reflect the conservation of matter in nature
- Aqueous Solutions and Solubility:if a substance dissolves in water, it is soluble.
- Some specific types of reactions are precipitation reaction, acid base reaction, gas-evolution reaction, redox reaction, and combustion reaction.
- Chemical reaction classifications are synthesis reaction, decomposition reactions, single-displacement reaction, and double displacement reaction.

Chapter 7: Chemical Skills Learning Objectives

1. LO: Identify a chemical reaction
2. LO: Write a balanced chemical equation
3. LO: Determine if a compound is soluble
4. LO: Predict and write equations for precipitation reactions
5. LO: Write molecular, complete ionic, and net ionic equations
6. LO: Identify and write equations for acid-base reactions
7. LO: Identify and write equations for gas-evolution reactions
8. LO: Identify redox reactions
9. LO: Identify and write equations for combustion reactions
10. LO: Classify chemical reactions.

Chapter 8: Quantities in Chemical Reactions

- Stoichiometry: A balanced chemical equation gives quantitative relationships between the amounts of reactants and products. The quantitative relationship between reactants and products in a chemical reaction is called reaction stoichiometry.

Limiting Reactant, Theoretical Yield, and Percent Yield:

- The limiting reactant in a chemical reaction is the reactant that limits the amount of product that can be made.
- The theoretical yield in a chemical reaction is the amount of product that can be made from the limiting reactant
- The actual yield in a chemical reaction is the amount of product actually produced

- The percent yield in a chemical reaction is the actual yield divided by theoretical yield times 100.

Enthalpy of Reaction:

- The amount of heat released or absorbed by a chemical reaction under conditions of constant pressure is the enthalpy of reaction (ΔH_{rxn}).
- The magnitude of ΔH_{rxn} is associated with the stoichiometric amounts of reactants and products for the reaction as written.

1. LO: Recognize the numerical relationship between chemical quantities in a balanced chemical equation.
2. LO: Carry out mole-to-mole conversions between reactants and products based on the numerical relationship between chemical quantities in a balanced chemical equation.
3. LO: Carry out mass-to-mass conversions between reactants and products based on the numerical relationship between chemical quantities in a balanced chemical equation and molar masses.
4. LO: Calculate limiting reactant, theoretical yield and percent yield for a given amount of reactants in a balanced chemical equation.
5. LO: Calculate the amount of thermal energy emitted or absorbed by a chemical reaction.

Chapter 9: Electrons in Atoms on the Periodic Table

- **Light**, a form of electromagnetic radiation, exhibits both wavelike and particle-like behavior. Particles of light are called photons.
- **The Bohr Model:** The emission spectrum of hydrogen can be explained by the Bohr model for the hydrogen atom. Each orbit is specified by a quantum number (n), which also specifies the orbit's energy.
- **The Quantum-Mechanical model-** describes electron orbitals, which are electron probability maps that show the relative probability of finding an electron in various places surrounding the atomic nucleus
- **Electron Configuration-** indicates which orbitals are occupied for a particular atom. Orbitals are filled in order of increasing energy and obey the laws of the Pauli exclusion principle, (each orbital can hold a maximum of two electrons with opposing spins) and Hund's rule (electrons occupy orbitals of identical energy singly before pairing)
- **The Periodic Table:** Elements within the same column of the periodic table have similar outer electron configurations and the same number of valence electrons and therefore have similar chemical properties.
    - The periodic table is divisible into blocks (s block, p block, d block, and f block) in which particular sublevels are filled.
    - As you move across a period to the right in the periodic table, atomic size decreases, ionization energy decreases, and metallic character increases.

Chapter 10: Chemical Bonding

- Lewis Theory: Chemical bonds are formed when atoms transfer valence electrons (ionic bonding) or share valence electrons (covalent bonding) to attain noble gasses electron configurations
- Molecular Shapes: The shapes of molecules can be predicted by combining Lewis Theory with Valence Shell Electron Pair Repulsion (VSEPR) theory, where electron groups around the central atom repel one another and determine the geometry of molecule
- Electronegativity: Electronegativity refers to the relative ability of elements to attract electrons within a chemical bond.
- Electronegativity increases as you move to the right across a period in the periodic table and decrease as you move down a column.