

Advanced Chemistry Notes - Grade 10

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Contents



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Unit 1: Chemical Reactions and Stoichiometry

Concepts

- **Chemical Reactions:** Processes that involve the rearrangement of atoms and the formation of new substances with different chemical properties.
 - **Evidence of a Chemical Reaction:**
 - * **Color Change:** *Example: Rusting of iron (reddish-brown rust forms), ripening of fruit (color change indicates chemical changes in pigments), burning of wood (black ash from brown wood).*
 - * **Formation of a Gas (Bubbles):** *Example: Reaction of baking soda (sodium bicarbonate) and vinegar (acetic acid) produces carbon dioxide gas.*

- * **Formation of a Precipitate:** An insoluble solid that forms when two solutions are mixed. *Example: Reaction of silver nitrate and sodium chloride produces a white precipitate of silver chloride.*
 - * **Heat or Light Production:** *Example: Burning of fuels (combustion), reaction of alkali metals with water.*
 - * **Temperature Change:** Reactions can either release heat (exothermic) or absorb heat (endothermic).
- **Chemical Equations:** Symbolic representations of chemical reactions, using chemical formulas and symbols.
 - **Reactants:** Substances present at the beginning of a reaction, written on the left side of the equation.
 - **Products:** Substances formed during a reaction, written on the right side of the equation.
 - **Arrow:** Indicates the direction of the reaction (reactants to products).
 - **Coefficients:** Numbers placed in front of chemical formulas to balance the equation, ensuring that the number of atoms of each element is the same on both sides.
 - **States of Matter:** Symbols in parentheses indicate the physical state of each substance (s = solid, l = liquid, g = gas, aq = aqueous solution).
 - **Balancing Chemical Equations:**
 - **Law of Conservation of Mass:** Matter cannot be created or destroyed in a chemical reaction; it can only be transformed. This means that the total mass of the reactants must equal the total mass of the products.
 - **Methods:**
 - * **Inspection Method:** Balancing by trial and error, adjusting coefficients until the number of atoms of each element is equal on both sides.
 - * **Least Common Multiple (LCM) Method:** Using the least common multiple of the subscripts of atoms in the reactants and products to determine coefficients.
 - * **Algebraic Method:** Assigning variables to coefficients and solving algebraic equations to balance the equation.
 - **Types of Chemical Reactions:**

Types of Chemical Reactions

- **Combination (Synthesis):** Two or more substances combine to form a single product.
 - * **General Form:** $A + B \rightarrow AB$
 - * **Example:** $2\text{Mg(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{MgO(s)}$ (Burning of magnesium)
 - **Decomposition:** A single reactant breaks down into two or more products.
 - * **General Form:** $AB \rightarrow A + B$
 - * **Example:** $2\text{H}_2\text{O(l)} \rightarrow 2\text{H}_2\text{(g)} + \text{O}_2\text{(g)}$ (Electrolysis of water)
 - **Single Displacement (Replacement):** One element replaces another element in a compound.
 - * **General Form:** $A + BC \rightarrow B + AC$ (if A is more reactive than B)
 - * **Example:** $\text{Zn(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu(s)}$ (Zinc displaces copper)
 - **Double Displacement (Metathesis):** Two compounds exchange ions to form two new compounds.
 - * **General Form:** $AB + CD \rightarrow AD + CB$
 - * **Example:** $\text{AgNO}_3\text{(aq)} + \text{NaCl(aq)} \rightarrow \text{AgCl(s)} + \text{NaNO}_3\text{(aq)}$ (Formation of silver chloride precipitate)
- **Oxidation and Reduction (Redox) Reactions:** Reactions that involve the transfer of electrons between species.
 - **Oxidation:** Loss of electrons, increase in oxidation number.
 - **Reduction:** Gain of electrons, decrease in oxidation number.
 - **Oxidizing Agent:** The substance that causes oxidation (it is reduced).
 - **Reducing Agent:** The substance that causes reduction (it is oxidized).
 - **Applications:**
 - * **Corrosion:** The oxidation of metals (e.g., rusting of iron).
 - * **Combustion:** A rapid oxidation reaction that releases energy.

- * **Electrochemistry:** Redox reactions are the basis for batteries and fuel cells.
 - **Balancing Redox Reactions:** Techniques like the oxidation-number-change method are used.
- **Oxidation Number (Oxidation State):** A number assigned to an atom in a compound, indicating the general distribution of electrons among bonded atoms.
 - **Rules:** A set of rules is used to assign oxidation numbers (see textbook for details).
- **Molecular Mass (MM) and Formula Mass (FM):**
 - **Molecular Mass (MM):** The sum of the atomic masses of all the atoms in a molecule of a covalent compound. *Example: The molecular mass of water (H_2O) is 18 amu (2×1 amu for H + 16 amu for O).*
 - **Formula Mass (FM):** The sum of the atomic masses of all the atoms in a formula unit of an ionic compound. *Example: The formula mass of sodium chloride ($NaCl$) is 58.5 amu (23 amu for Na + 35.5 amu for Cl).*
- **The Mole Concept:** A fundamental concept in chemistry that relates the amount of a substance to the number of particles it contains.
 - **Mole:** The SI unit of amount. One mole of any substance contains Avogadro's number (6.022×10^{23}) of particles (atoms, molecules, ions, etc.).
 - **Molar Mass:** The mass of one mole of a substance.
- **Chemical Formulas - Empirical and Molecular Formulas:**
 - **Empirical Formula:** Shows the simplest whole-number ratio of atoms in a compound.
 - **Molecular Formula:** Shows the actual number of atoms of each element in a molecule.
 - **Percent Composition:** The percentage by mass of each element in a compound.
- **Stoichiometry:** The study of the quantitative relationships between reactants and products in chemical reactions.
 - **Mole Ratios:** The coefficients in a balanced chemical equation represent the mole ratios between reactants and products.
 - **Mass-Mass Relationships:** Stoichiometric calculations can be used to determine the masses of reactants or products involved in a reaction.

- **Mass-Volume Relationships:** Calculations involving the masses of reactants or products and the volumes of gases (at STP).
- **Volume-Volume Relationships:** Calculations involving the volumes of gaseous reactants and products (at STP).
- **Limiting Reactant:** The reactant that is completely consumed first in a reaction, limiting the amount of product that can be formed.
- **Excess Reactant:** The reactant that is left over after the limiting reactant is consumed.
- **Theoretical Yield:** The maximum amount of product that can be formed based on the stoichiometry of the reaction.
- **Actual Yield:** The amount of product actually obtained in an experiment.
- **Percent Yield:** The ratio of the actual yield to the theoretical yield, expressed as a percentage.