Chapter 8 Quiz - Revision

Quiz Details

- **Date and Time:** Tuesday, September 30th, between 7:00 AM and 7:30 AM.
- **Format:** Closed notes.
- **Allowed Materials:** A clean, unmarked copy of the provided periodic table ("Periodic Table for testing.pdf"). Ensure there is no writing on it.

Key Topics on the Quiz

1. Balancing chemical equations and identifying the type of reaction (synthesis, decomposition, single exchange, double exchange, combustion).
2. Calculating the molecular formula from a given empirical formula and molar mass.
3. Calculating the theoretical yield of a product when one reactant is explicitly stated to be in excess.

Phase 1: Foundation & Review (Friday - Saturday)

- **Understand Reaction Types:** Review slides 12-17 in `Chapter 8 Powerpoint.pdf`. Focus on the definitions and general forms (e.g., A + B $\rightarrow$ AB for synthesis) for each reaction type.
- **Master Balancing Equations:** Review slides 6-11 in `Chapter 8 Powerpoint.pdf`. Pay close attention to the strategy of balancing compounds first and treating polyatomic ions as single units.
- **Review Stoichiometry Concepts:** Refresh your understanding of mole-to-mole and gram-to-gram conversions by reviewing slides 25-31 in `Chapter 8 Powerpoint.pdf`. This is the foundation for theoretical yield problems.

Phase 2: Practice & Application (Saturday - Sunday)

- **Practice Balancing and Classifying:** Complete problems 1a through 1l on the first page of `Types of Chemical Reactions.pdf`. Check your answers against the solutions provided on the sheet. For extra practice, work through problems 6a, 6b, 6c, and 6e on page 4.
- **Practice Theoretical Yield:** Work through problem 4 from `Limiting Reagent Worksheet.pdf`. This problem is a perfect example of a theoretical yield calculation where one reactant is in excess. A detailed explanation is provided below.

- **Practice Molecular Formula Calculation:** The second half of the combustion analysis problem on slides 23-24 of `Chapter 8 Powerpoint.pdf` is an exact model for the type of question on the quiz. Focus on how to get from the empirical formula to the molecular formula.

Phase 3: Final Mastery (Monday)

- **Review Explanations:** Carefully read through the detailed explanations of the practice problems in the next section of this guide. Make sure you understand every step.
- **Self-Correction:** Re-attempt any problems you struggled with during Phase 2. Do not look at the answers until you have made a genuine effort to solve them yourself.
- **Final Preparation:** Print a clean, unmarked copy of `Periodic Table for testing.pdf`. Put it with your backpack and other school materials so you don't forget it. Get a good night's sleep!

Explanations of Practice Problems

Topic 1: Balancing Equations & Identifying Reaction Types

Problem: From `Types of Chemical Reactions.pdf`, problem 6c. Balance the reaction and state its type:

$$\_\_\ \mathrm{Mg(s)} + \_\_\ \mathrm{Fe_2O_3(s)} \rightarrow \_\_\ \mathrm{Fe(s)} + \_\_\ \mathrm{MgO(s)}$$

1. **Initial Atom Count:**
   - Reactants: Mg (1), Fe (2), O (3)
   - Products: Fe (1), Mg (1), O (1)

   The equation is not balanced.

2. **Balance Iron (Fe):** There are 2 Fe atoms on the reactant side and 1 on the product side. Place a coefficient of **2** in front of Fe on the product side.

   $$\_\_\ \mathrm{Mg(s)} + \_\_\ \mathrm{Fe_2O_3(s)} \rightarrow \mathbf{2}\ \mathrm{Fe(s)} + \_\_\ \mathrm{MgO(s)}$$

   New Count: Reactants: Mg(1), Fe(2), O(3). Products: Fe(2), Mg(1), O(1).

3. **Balance Oxygen (O):** There are 3 O atoms on the reactant side and 1 on the product side. Place a coefficient of **3** in front of MgO.

   $$\_\_\ \mathrm{Mg(s)} + \_\_\ \mathrm{Fe_2O_3(s)} \rightarrow 2\ \mathrm{Fe(s)} + \mathbf{3}\ \mathrm{MgO(s)}$$

   New Count: Reactants: Mg(1), Fe(2), O(3). Products: Fe(2), Mg(3), O(3).

4. **Balance Magnesium (Mg):** Now there is 1 Mg atom on the reactant side and 3 on the product side. Place a coefficient of **3** in front of Mg.

   $$\mathbf{3}\ \mathrm{Mg(s)} + \_\_\ \mathrm{Fe_2O_3(s)} \rightarrow 2\ \mathrm{Fe(s)} + 3\ \mathrm{MgO(s)}$$

   Final Count: Reactants: Mg(3), Fe(2), O(3). Products: Fe(2), Mg(3), O(3). The equation is balanced! Note that the coefficient for Fe_2O_3 is an implied **1**.

5. **Identify the Reaction Type:** In this reaction, an element (Mg) reacts with a compound (Fe_2O_3) and displaces another element (Fe) from the compound. This is the definition of a **Single Exchange** (or single replacement) reaction.

Topic 2: Molecular Formula from Empirical Formula

Problem: Adapted from `Chapter 8 Powerpoint.pdf`, slide 24. A compound has the empirical formula $\mathbf{CH_2O}$ and a molar mass of approximately **180. g/mol**. What is its molecular formula?

1. **Calculate the Empirical Formula Mass:** First, find the mass of one mole of the empirical formula unit (CH_2O) using the periodic table.

$$\begin{array}{r} \text{C: } 1 \times 12.01 \text{ g/mol} = 12.01 \text{ g/mol} \\ \text{H: } 2 \times 1.01 \text{ g/mol} = 2.02 \text{ g/mol} \\ \text{O: } 1 \times 16.00 \text{ g/mol} = 16.00 \text{ g/mol} \\ \hline \textbf{Total Empirical Mass} = \textbf{30.03 g/mol} \end{array}$$

2. **Find the Whole-Number Multiplier (n):** The molecular formula is always a whole-number multiple of the empirical formula. To find this multiplier, divide the given molecular molar mass by the calculated empirical formula mass.

$$n = \frac{\text{Molecular Molar Mass}}{\text{Empirical Formula Mass}} = \frac{180 \text{ g/mol}}{30.03 \text{ g/mol}} \approx 5.99 \approx \mathbf{6}$$

3. **Determine the Molecular Formula:** Multiply the subscripts in the empirical formula by the whole-number multiplier (n=6).

$$(\text{CH}_2\text{O})_n = (\text{CH}_2\text{O})_6 = \mathbf{C_6H_{12}O_6}$$

   The molecular formula of the compound is $C_6H_{12}O_6$.

Topic 3: Theoretical Yield with a Reactant in Excess

Problem: From `Limiting Reagent Worksheet.pdf`, problem 4b. "A chemist burns 160.0 g of Al in excess air to produce aluminum oxide, Al_2O_3... Calculate the theoretical yield of this reaction."

1. **Write a Balanced Equation:** The reaction is aluminum combining with oxygen (from the air) to form aluminum oxide.

$$4 \text{ Al(s)} + 3 \text{ O}_2\text{(g)} \rightarrow 2 \text{ Al}_2\text{O}_3\text{(s)}$$

2. **Identify the Limiting Reactant:** The problem states that Al is burned in **excess air**. This means oxygen (O_2) is the excess reactant. By definition, **aluminum (Al) is the limiting reactant**. The theoretical yield must be calculated based on the amount of Al.

3. **Convert Grams of Limiting Reactant to Moles:** Use the molar mass of Al (26.98 g/mol) to find the number of moles in 160.0 g of Al.

$$160.0 \text{ g Al} \times \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} = 5.930 \text{ mol Al}$$

4. **Use Mole Ratio to Find Moles of Product:** Use the stoichiometric coefficients from the balanced equation to convert moles of Al to moles of Al_2O_3. The ratio is 4 moles of Al produce 2 moles of Al_2O_3.

$$5.930 \text{ mol Al} \times \frac{2 \text{ mol Al}_2\text{O}_3}{4 \text{ mol Al}} = 2.965 \text{ mol Al}_2\text{O}_3$$

5. **Convert Moles of Product to Grams:** Use the molar mass of Al_2O_3 (101.96 g/mol) to find the mass of the product. This final mass is the theoretical yield.

$$2.965 \text{ mol Al}_2\text{O}_3 \times \frac{101.96 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} = \mathbf{302.3} \text{ g Al}_\mathbf{2}\text{O}_\mathbf{3}$$

   The theoretical yield of aluminum oxide is **302.3 grams**.

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