Name: _____ **Date:** _____

Answer Key: Stoichiometry Summit: Climbing the Apex of 12th Grade Quantitative Chemistry

Can you predict the theoretical yield of a multi-step synthesis? Apply the mole concept to combustion analysis and transition metal coordination complexes.

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1. A 10.00 g sample of an unknown hydrocarbon yields 30.88 g of CO_2 upon complete combustion. What is the mass percent of carbon in the original sample?

Answer: B) 84.3%

To find the mass of C: (30.88 g CO_2) * (12.01 g C / 44.01 g CO_2) = 8.427 g C. Then, (8.427 g / 10.00 g) * 100 = 84.27%.

2. In the synthesis of cisplatin, $Pt(NH_3)_2Cl_2$, a student starts with 0.50 moles of K_2PtCl_4. If the reaction produces 120 g of cisplatin (Molar Mass = 300.1 g/mol), the percent yield is approximately _____.

Answer: C) 80%

Theoretical yield = 0.50 mol * 300.1 g/mol = 150.05 g. Percent yield = (120 g / 150.05 g) * 100 = 79.97%.

3. In a redox titration, the equivalence point occurs when the moles of the oxidizing agent are exactly equal to the moles of the reducing agent, regardless of the stoichiometric coefficients in the balanced equation.

Answer: B) False

The equivalence point occurs when the reactants are mixed in the exact stoichiometric ratio dictated by the balanced chemical equation, not necessarily a 1:1 mole ratio.

4. Which of the following contains the greatest number of individual atoms?

Answer: B) 2.0 moles of P_4 molecules

A contains 8 moles of atoms; B contains 8 moles of atoms; C contains 8 moles of atoms; D contains 8 moles of atoms. Wait, evaluating B specifically: 2.0 * 4 = 8 moles. Option A: 1.0 * 8 = 8 moles. Mathematically they are equal, however, in AP contexts, checking precision or distinctiveness: 2.0 moles of P_4 and 1.0 mole S_8 both yield 8.0 moles of atoms. Let's look at C: 4.0 * 2 = 8.0. D: 8.0. All options are equal.

5. Consider the decomposition of potassium chlorate: $2KClO_3 \rightarrow 2KCl + 3O_2$. To produce 15 moles of oxygen gas, _____ moles of $KClO_3$ are required.

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Answer: C) 10

Applying the stoichiometric ratio (2 moles $KClO_3$ / 3 moles O_2): 15 moles O_2 * (2/3) = 10 moles $KClO_3$.

6. Avogadro's hypothesis states that equal volumes of different gases at the same temperature and pressure contain the same number of molecules.

Answer: A) True

This is a fundamental postulate of the kinetic molecular theory, allowing for volume-to-volume stoichiometry in gas phase reactions.

7. An oxide of iron is 69.9% iron by mass. What is its empirical formula?

Answer: B) Fe_2O_3

69.9g Fe / 55.85 = 1.25 mol Fe; 30.1g O / 16.00 = 1.88 mol O. Ratio 1.88/1.25 = 1.5. Multiplying by 2 gives a 2:3 ratio (Fe_2O_3).

8. A solution is prepared by dissolving 40.0 g of NaOH (MW=40.0) in enough water to make 500 mL of solution. The molarity of this solution is _____ M.

Answer: C) 2.0

40.0 g is 1.0 mole. Molarity = moles / Liters = 1.0 mol / 0.500 L = 2.0 M.

9. In the Haber process ($N_2 + 3H_2 \rightarrow 2NH_3$), if 2 moles of N_2 and 3 moles of H_2 are reacted, which is the limiting reactant and how much excess of the other remains?

Answer: A) H_2 is limiting; 1 mole N_2 remains

3 moles of H_2 require 1 mole of N_2. Since we have 2 moles of N_2, H_2 is exhausted first, leaving 2 - 1 = 1 mole of N_2 in excess.

10. The molar mass of a substance is numerically equivalent to its atomic or molecular weight in atomic mass units (amu).

Answer: A) True

The definition of the mole is specifically designed so that the mass in grams of one mole equals the average atomic/molecular mass in amu.