Name: _____ **Date:** _____

Answer Key: Yielding Results: Advanced Stoichiometry for 10th Grade Chemists

Calculate theoretical limits and investigate reagent scarcity to refine industrial synthesis skills and laboratory precision.

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1. A metallurgical engineer reacts 150.0 g of iron(III) oxide (Fe_2O_3) with excess carbon monoxide to produce iron and carbon dioxide. If the process yields an 85.0% recovery, what is the actual mass of iron produced?

Answer: B) 89.2 g

Calculated by: (150g Fe_2O_3 / 159.7 g/mol) * (2 mol Fe / 1 mol Fe_2O_3) * 55.85 g/mol = 104.9g theoretical yield. Actual yield = 104.9g * 0.85 = 89.2g.

2. In the combustion of a hydrocarbon, the limiting reactant is always determined by the substance with the lowest initial mass.

Answer: B) False

The limiting reactant depends on the molar ratio and the number of moles available, not the absolute mass; a substance with a lower mass can still be in excess if it has a very low molar mass.

3. When balancing the decomposition of potassium chlorate ($KClO_3$) into potassium chloride and oxygen gas, the stoichiometric coefficient for oxygen gas is _____.

Answer: C) 3

The balanced equation is $2KClO_3 \rightarrow 2KCl + 3O_2$; therefore, the coefficient for oxygen is 3.

4. An unknown gas has a density of 1.783 g/L at STP. Which of the following is most likely the identity of the gas?

Answer: B) Argon (Ar)

At STP, 1 mole of gas occupies 22.4L. Molar mass = density * molar volume = 1.783 g/L * 22.4 L/mol = 39.94 g/mol, which matches Argon.

5. A sample contains 40.0% carbon, 6.7% hydrogen, and 53.3% oxygen by mass. The empirical formula for this compound is _____.

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Answer: D) CH_2O

Converting to moles: C = 3.33, H = 6.64, O = 3.33. Dividing by the smallest value (3.33) yields a ratio of 1:2:1 (CH_2O).

6. The percent yield of a chemical reaction can never exceed 100% if the product is pure and all measurements are accurate.

Answer: A) True

The Law of Conservation of Mass dictates that matter cannot be created; a yield over 100% usually indicates impurities such as unevaporated solvent.

7. In the synthesis of aspirin, 2.0 g of salicylic acid ($C_7H_6O_3$) reacts with excess acetic anhydride. If the actual yield of aspirin ($C_9H_8O_4$) is 1.5 g, what is the percent yield?

Answer: C) 57.5%

Theoretical yield = (2g / 138.12 g/mol) * 180.16 g/mol = 2.61g. Percent yield = (1.5g / 2.61g) * 100 = 57.5%.

8. According to Avogadro's Hypothesis, equal volumes of gases at the same temperature and pressure contain an equal number of _____.

Answer: C) Molecules

Avogadro's law states that volume is directly proportional to the number of moles (molecules/particles) of gas, regardless of the gas identity.

9. If 10.0 g of Magnesium is reacted with 10.0 g of Oxygen gas to form MgO, which reactant is limiting and how much MgO is produced?

Answer: B) Mg is limiting; 16.6 g MgO

Mg: 10g/24.3 = 0.412 mol. O_2: 10g/32 = 0.312 mol. Stoichiometry: $2Mg + O_2 \rightarrow 2MgO$. Mg requires 0.206 mol O_2. Since 0.312 mol O_2 is available, Mg is limiting. 0.412 mol Mg produces 0.412 mol MgO (16.6g).

10. The molar mass of a diatomic element is exactly twice the atomic mass listed on the periodic table for that element.

Answer: A) True

Diatomic elements (H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2) consist of two atoms per molecule, so their molar mass is 2 * the atomic weight of the single atom.