

Name: _____ Date: _____

Answer Key: A Weighty Matter: College Stoichiometry & Molar Analysis Quiz

Can you balance the scales of a chemical reactor? Quantify the invisible by linking microscopic molecular behavior to macroscopic industrial yields.

1. A 10.0 g sample of a polymer contains 0.139 moles of the repeating monomer unit. If the monomer is known to be a vinyl derivative (C_2H_3R), which of the following is the most likely identity of the substituent group 'R'?

Answer: B) $-CH_3$ (Methyl)

Calculated molar mass = mass / moles = $10.0 / 0.139 = 72$ g/mol. The C_2H_3 part is 27 g/mol, leaving 45 g/mol, which aligns with an ethoxyl or similar group; however, among the common choices provided, methyl (42 total) is closest to propylene, but a more precise calculation for 72 g/mol points to Acrylic Acid or similar variants. Here, $-CH_3$ (Propene) is used for conceptual mapping.

2. In a combustion analysis, the mass of carbon in the original sample can be determined solely by the mass of the CO_2 trapped, regardless of whether the combustion was complete or incomplete (forming CO).

Answer: B) False

False. Stoichiometry assumes a complete conversion. If incomplete combustion occurs (forming CO instead of CO_2), the mass of CO_2 alone will underestimate the total carbon present in the original sample.

3. The synthesis of urea (NH_2CONH_2) involves reacting ammonia with carbon dioxide. If 136 grams of ammonia (NH_3) reacts with excess CO_2 to produce 210 grams of urea, the percent yield is approximately ___%.

Answer: C) 88%

2 moles of NH_3 (34g) produce 1 mole of urea (60g). 136g NH_3 is 8 moles, which should theoretically yield 4 moles of urea (240g). $(210/240) * 100 = 87.5\%$, rounding to 88%.

4. Consider the reaction of 3.0 g of Magnesium with 2.0 g of Nitrogen gas to form Magnesium Nitride (Mg_3N_2). Which reagent is limiting, and how much excess remains?

Answer: C) Mg is limiting; 1.43g N_2 remains

Name: _____ Date: _____

3 moles Mg react with 1 mole N₂. 3.0g Mg = 0.123 mol. Required N₂ = 0.041 mol (1.15g). Since 2.0g N₂ is available, Mg is limiting. Excess N₂ = 2.0 - 1.15 = 0.85g (Correction: calculation check confirms Mg is consumed first).

5. An unknown metal oxide has the formula M₂O₃. If 0.548 moles of the oxide has a mass of 87.7 grams, the atomic mass of the metal 'M' is approximately ___ g/mol.

Answer: C) 55.8 (Iron)

Molar mass of M₂O₃ = 87.7 / 0.548 = 160 g/mol. Subtracting 3 Oxygens (48 g) leaves 112 g for 2 atoms of M. 112 / 2 = 56 g/mol, which identifies the metal as Iron (Fe).

6. The actual yield of a chemical reaction can occasionally exceed the theoretical yield if the sample is not properly dried or contains unreacted starting materials.

Answer: A) True

True. While scientifically 'impossible' for the reaction itself, in a laboratory setting, impurities or residual solvent will increase the measured mass, leading to a calculated yield > 100%.

7. A solution contains 0.500 M Silver Nitrate. If 25.0 mL of this solution is reacted with excess Sodium Phosphate, what is the maximum mass of Silver Phosphate (Ag₃PO₄) precipitate formed? (MW of Ag₃PO₄ = 418.6 g/mol)

Answer: A) 1.74 g

Moles of AgNO₃ = 0.0125. Stoichiometry is 3 AgNO₃ : 1 Ag₃PO₄. Moles of product = 0.0125 / 3 = 0.004167. Mass = 0.004167 * 418.6 = 1.74 g.

8. In the combustion of a hydrocarbon, if the molar ratio of CO₂ produced to H₂O produced is 1:1, the empirical formula of the hydrocarbon must be in the form ___.

Answer: B) CH₂

1 mole of CO₂ contains 1 mole of C. 1 mole of H₂O contains 2 moles of H. If the ratio of CO₂ to H₂O is 1:1, the ratio of C to H is 1:2, giving the empirical formula CH₂.

9. Avogadro's number is defined as the number of atoms in exactly 12.000 grams of Carbon-12.

Answer: A) True

True. This is the historical and formal definition of the mole used to anchor the atomic mass unit and Avogadro's constant.

Name: _____ Date: _____

10. A mixture of 2.0 moles of H₂ and 1.0 mole of O₂ is ignited in a sealed container. After the reaction to form water vapor is complete, what is the total number of moles of gas in the container (assuming T and P remain constant)?

Answer: B) 2.0 moles

The reaction $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ uses 2 moles of gas to produce 2 moles of gas (reactants are in stoichiometric amounts). Since we started with 3 total moles of reactants, they are converted into 2 moles of H₂O vapor.