

Name: _____ Date: _____

Stoichiometry Mastery for University Chemists

Calculate theoretical yields, analyze limiting reagents in complex redox reactions, and evaluate multi-step industrial synthesis efficiency through rigorous quantitative modeling.

1. A 10.0 g sample of a titanium-iron alloy is reacted with excess hydrochloric acid, producing 0.402 grams of hydrogen gas. If only the titanium reacts to form TiCl_3 and the iron remains inert, what is the mass percentage of titanium in the alloy?

- A. 63.7%
- B. 42.5%
- C. 9.52%
- D. 12.7%

2. In the combustion of a complex hydrocarbon fuel (C_xH_y) where 0.100 moles of fuel produces 0.800 moles of CO_2 and 0.900 moles of H_2O , the empirical formula of the fuel is ____.

- A. C_8H_9
- B. C_4H_9
- C. C_8H_{18}
- D. C_4H_{10}

3. True or False: In a non-ideal gaseous reaction system at high pressure, the stoichiometric coefficients of a balanced equation accurately represent the volume-to-volume ratios of the reactants and products.

- A. True
- B. False

4. During the synthesis of aspirin, 2.0 g of salicylic acid ($\text{MW}=138$) reacts with 4.0 g of acetic anhydride ($\text{MW}=102$). If the yield is 75%, what mass of aspirin ($\text{MW}=180$) is actually collected?

- A. 1.96 g
- B. 2.61 g
- C. 5.30 g
- D. 1.45 g

5. A 1.50 g sample of an unknown nitrate salt $\text{M}(\text{NO}_3)_2$ is decomposed to form 0.701 g of the metal oxide MO . The atomic mass of metal M is approximately ____ g/mol.

- A. 40.1
- B. 65.4
- C. 137.3
- D. 56.1

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6. In the analysis of a 2.50 g hydrate of copper(II) sulfate ($\text{CuSO}_4 \cdot n\text{H}_2\text{O}$), the sample is heated until a constant mass of 1.60 g is reached. What is the value of 'n'?

- A. 2
- B. 3
- C. 5
- D. 7

7. True or False: The 'limiting reactant' in a chemical process is always the substance present in the smallest mass quantity.

- A. True
- B. False

8. Consider the reaction: $3\text{MnO}_2 + 4\text{Al} \rightarrow 3\text{Mn} + 2\text{Al}_2\text{O}_3$. If you react 1.0 mol of MnO_2 with 1.0 mol of Al, the amount of Mn produced is ___ moles.

- A. 1.00
- B. 0.75
- C. 0.67
- D. 1.33

9. If a titration requires 25.00 mL of 0.100 M KMnO_4 to react completely with 20.00 mL of an acidified FeSO_4 solution, what is the molarity of the Fe^{2+} ions? ($5\text{Fe}^{2+} + \text{MnO}_4^- + 8\text{H}^+ \rightarrow 5\text{Fe}^{3+} + \text{Mn}^{2+} + 4\text{H}_2\text{O}$)

- A. 0.125 M
- B. 0.625 M
- C. 0.020 M
- D. 0.500 M

10. True or False: In a combustion analysis of an organic compound containing C, H, and O, the mass of oxygen in the original sample must be determined by subtracting the calculated masses of C and H from the total initial sample mass.

- A. True
- B. False