Name: _____ **Date:** _____

A Mole of Two Cities: Advanced 12th Grade Reaction Stoichiometry

Students synthesize complex limiting reactant data and gas laws to predict yields in multicomponent industrial and environmental chemical systems.

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1. A 10.0 g sample of impure magnesium carbonate ($MgCO_3$) is decomposed to form MgO and CO_2. If 3.82 g of MgO is actually recovered, and the reaction has a 92% yield, what was the approximate mass percent of $MgCO_3$ in the original sample? (Molar masses: $MgCO_3$ = 84.3 g/mol, MgO = 40.3 g/mol)

A. 79.8%
B. 87.1%
C. 91.3%
D. 95.2%

2. In the combustion of a complex hydrocarbon, if the calculated mass of water produced exceeds the initial mass of the fuel, the Law of Conservation of Mass has been violated.

A. True
B. False

3. An unknown gas with a mass of 1.43 g occupies 0.500 L at 298 K and 1.00 atm. Using the ideal gas law (R=0.0821) and the mole concept, identify the likely identity of this diatomic gas: _____.

A. Oxygen (O_2)
B. Nitrogen (N_2)
C. Chlorine (Cl_2)
D. Fluorine (F_2)

4. Consider the titration of 25.0 mL of 0.150 M H_2SO_4 with 0.200 M KOH. What volume of KOH is required to reach the second equivalence point?

A. 18.75 mL
B. 37.50 mL
C. 50.00 mL
D. 75.00 mL

5. In the synthesis of adipic acid for nylon production, a chemist uses 120 g of cyclohexane (C_6H_{12}) as the starting material. If the theoretical mole ratio of cyclohexane to adipic acid ($C_6H_{10}O_4$) is 1:1, the theoretical yield of adipic acid is _____ grams.

A. 146.1 g
B. 165.2 g
C. 208.4 g
D. 240.2 g

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6. At constant temperature and pressure, the volume ratios of gaseous reactants and products are equivalent to their stoichiometric mole ratios.

A. True
B. False

7. Determine the limiting reactant when 5.0 moles of Silver Nitrate ($AgNO_3$) reacts with 2.0 moles of Aluminum Chloride ($AlCl_3$) to form Silver Chloride and Aluminum Nitrate.

A. Silver Nitrate
B. Aluminum Chloride
C. Silver Chloride
D. Neither; they are in stoichiometric proportion

8. A hydrate of Cobalt(II) chloride, $CoCl_2 \cdot xH_2O$, is heated. The mass of the sample drops from 2.38 g to 1.30 g. The integer value of 'x' in the formula is _____.

A. 2
B. 4
C. 6
D. 10

9. The empirical formula of a compound can be determined using only the percent composition by mass, without knowing the total molar mass of the compound.

A. True
B. False

10. In a redox titration, 32.0 mL of 0.100 M $KMnO_4$ is needed to oxidize 25.0 mL of an acidic Fe^{2+} solution to Fe^{3+}. What is the molarity of the Fe^{2+} solution? (Mn is reduced from +7 to +2)

A. 0.128 M
B. 0.400 M
C. 0.640 M
D. 0.320 M