1. (a) How many grams of CO₂ are there in 2.55 mol of CO₂? (b) How many molecules of CO₂ are there in 2.55 mol of CO₂?

2. Consider the following unbalanced reaction:

\[ \_ \text{C}_4\text{H}_{10} + \_ \text{O}_2 \rightarrow \_ \text{CO}_2 + \_ \text{H}_2\text{O} \]

a. How many moles of H₂O form when 4.00 moles of C₄H₁₀ react?

b. How many moles of C₄H₁₀ are needed to react with 5.00 moles of O₂?

3. Calculate the mass of hydrochloric acid, HCl, that will be needed to react with 125 g of Al in the following reaction. (MM: Al = 26.98 g/mol; HCl = 36.46 g/mol, AlCl₃ = 133.34 g/mol; H₂ = 2.02 g/mol)

\[ 2\text{Al(s)} + 6\text{HCl(g)} \rightarrow 2\text{AlCl}_3(s) + 3\text{H}_2(g) \]
4. Sodium and sulfur react to form sodium sulfide according to the following equation:

\[ 2Na + S \rightarrow Na_2S \]

Calculate the number of grams of sulfur needed to ensure a complete reaction with 50.0 g of sodium. (10 pts)

Limiting Reactants

5. The lunar module (LM) which was used to land on the surface of the moon during the Apollo missions used a mixture of hydrazine, \( N_2H_4 \), and dinitrogen tetroxide, \( N_2O_4 \), as a fuel source (the molar masses of the reactants and products are written under the equation):

\[ 2N_2H_4(l) + N_2O_4(l) \rightarrow 3N_2(g) + 4H_2O(g) \]

32.05 g/mol   92.01 g/mol   28.01 g/mol   18.02 g/mol

During an experiment, 325 g of \( N_2H_4 \) and 325 g of \( N_2O_4 \) are mixed. (30 pts)

a. Which of the two reactants is the limiting reagent, and what is the theoretical yield of \( N_2 \)?

b. What is the theoretical yield of \( H_2O \)?

c. How many grams of excess reagent will be left over?

a. ______________

b. ______________

c. ______________
6. Acrylonitrile (C₃H₃N) is the starting material for many synthetic carpets and fabrics. It is produced by the following reaction:

\[ 2\text{C}_3\text{H}_6(g) + 2\text{NH}_3(g) + 3\text{O}_2(g) \rightarrow 2\text{C}_3\text{H}_3\text{N}(g) + 6\text{H}_2\text{O}(g) \]

If 5.00 g C₃H₆, 20.0 g O₂, and 15.0 g NH₃ are reacted, what is the limiting reactant, and what is the theoretical yield of acrylonitrile? (10 pts)

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Percent Composition and Empirical Formulas

7. A compound of nitrogen and oxygen with a molecular mass of 76.01 g/mol contains 36.85% N and 63.15% O. Calculate the empirical and molecular formulas, arranging the atoms in the order NO. (10 pts)

8. Cryofluorane, also known as Freon 114, is a chlorofluorocarbon which was once used as a refrigerant and an aerosol propellant. It contains carbon, fluorine, and chlorine. The percent composition of this substance is 14.05%C, 44.46%F, and 41.48%Cl, and the molar mass is 170.92 g/mol. What are the empirical and molecular formulas of cryofluorane? (Write the symbols in the order C, F, Cl.) (10 pts)