1. Given the equation \(2 \text{C}_4\text{H}_{10} + 13 \text{O}_2 \rightarrow 8 \text{CO}_2 + 10 \text{H}_2\text{O}\), what are the mole ratios for the following?

   a. convert moles \(\text{C}_4\text{H}_{10}\) to moles \(\text{O}_2\)
      \[
      \frac{13 \text{ mol } \text{O}_2}{2 \text{ mol } \text{C}_4\text{H}_{10}}
      \]

   b. convert moles \(\text{O}_2\) to moles \(\text{CO}_2\)
      \[
      \frac{8 \text{ mol } \text{CO}_2}{13 \text{ mol } \text{O}_2}
      \]

   c. convert moles \(\text{O}_2\) to moles \(\text{H}_2\text{O}\)
      \[
      \frac{10 \text{ mol } \text{H}_2\text{O}}{13 \text{ mol } \text{O}_2}
      \]

   d. convert moles \(\text{C}_4\text{H}_{10}\) to moles \(\text{CO}_2\)
      \[
      \frac{8 \text{ mol } \text{CO}_2}{2 \text{ mol } \text{C}_4\text{H}_{10}}
      \]

   e. convert moles \(\text{C}_4\text{H}_{10}\) to moles \(\text{H}_2\text{O}\)
      \[
      \frac{10 \text{ mol } \text{H}_2\text{O}}{2 \text{ mol } \text{C}_4\text{H}_{10}}
      \]

   f. convert moles \(\text{H}_2\text{O}\) to moles \(\text{O}_2\)
      \[
      \frac{13 \text{ mol } \text{O}_2}{10 \text{ mol } \text{H}_2\text{O}}
      \]

2. Given the following equation: \(2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2\)

   How many moles of \(\text{O}_2\) can be produced by letting 12.00 moles of \(\text{KClO}_3\) react?

   \[
   12.00 \text{ mol KClO}_3 \times \frac{3 \text{ mol } \text{O}_2}{2 \text{ mol KClO}_3} = 18.00 \text{ mol } \text{O}_2
   \]
3. Given the following equation: \(2K + Cl_2 \rightarrow 2KCl\)

\[
\frac{2.50 \text{ g } K}{39.10 \text{ g } K} \times \frac{2 \text{ mol } KCl}{2 \text{ mol } K} \times \frac{74.55 \text{ g } KCl}{1 \text{ mol } KCl} = 4.77 \text{ g } KCl
\]

a. How many grams of KCl are produced from 2.50 g of K and excess Cl\(_2\)?

b. How many grams of KCl are produced from 1.00 kg of Cl\(_2\) and excess K?

4. Given the following equation: \(Na_2O + H_2O \rightarrow 2NaOH\)

\[
\frac{1.20 \times 10^2 \text{ g } Na_2O}{61.98 \text{ g } Na_2O} \times \frac{1 \text{ mol } Na_2O}{1 \text{ mol } Na_2O} \times \frac{40.00 \text{ g } NaOH}{2 \text{ mol } NaOH} = 155 \text{ g }
\]

a. How many grams of NaOH are produced from 1.20 x 10\(^2\) grams of Na\(_2\)O?

b. How many grams of Na\(_2\)O are required to produce 1.60 x 10\(^4\) grams of NaOH?

5. At 790 K, uranium dioxide is oxidized in contact with oxygen gas to form triuranium octoxide.

a. Write the balanced equation:

\[3UO_2 + O_2 \rightarrow U_3O_8\]

b. A chemist requires 500.0 milligrams of triuranium octoxide. How many milligrams of uranium dioxide should she react with excess oxygen gas?

\[
\frac{500.0 \text{ mg } U_3O_8}{1000 \text{ mg}} \times \frac{1 \text{ g } U_3O_8}{842.0 \text{ g } U_3O_8} \times \frac{3 \text{ mol } UO_2}{1 \text{ mol } U_3O_8} \times \frac{270.0 \text{ g } UO_2}{1 \text{ mol } UO_2} = 481.0 \text{ mg } UO_2
\]
6. Given the following equation: \(8\text{Fe} + \text{S}_8 \rightarrow 8\text{FeS}\)

a. If a chemist reacts 50.00 g of iron with 45.10 g of \(\text{S}_8\), how many grams of \(\text{FeS}\) can be produced?

\[\begin{align*}
\text{Fe} & \quad \text{S}_8 \\
50.00 \text{g} & \quad 45.10 \text{g} \\
55.85 \text{g/mol} & \quad 256.56 \text{g/mol}
\end{align*}\]

\[
\text{available: } 0.8953 \text{ mol} \quad 0.1758 \text{ mol}
\]

\[
\text{required: } 1.406 \text{ mol} \quad 0.1119 \text{ mol}
\]

\[
\text{Fe is } \text{limiting} \text{ because more is required than is available. } \text{S}_8 \text{ is } \text{excess} \text{ because more is available than required.}
\]

Because \(\text{Fe}\) will run out before \(\text{S}_8\) does in the reaction, it must be used to determine the mass of any product.

\[
\begin{align*}
\text{Molar masses:} \\
\text{Fe} &= 55.85 \text{ g/mol} \\
\text{S}_8 &= 256.56 \text{ g/mol} \\
\text{FeS} &= 87.92 \text{ g/mol}
\end{align*}
\]

\[
\begin{align*}
\text{FeS produced using the limiting reactant: } \\
50.00 \text{g Fe} & \times \frac{1 \text{ mol Fe}}{55.85 \text{g Fe}} \times \frac{8 \text{ mol FeS}}{8 \text{ mol Fe}} \times \frac{87.92 \text{g FeS}}{1 \text{ mol FeS}} = 78.71 \text{ g FeS}
\end{align*}
\]

b. Which is the excess reactant? How many grams of it remain after the reaction is completed?

\[
\text{S}_8 \text{ is } \text{excess}. \text{ Moles available – moles required } = 0.1758 \text{ mol } – 0.1110 \text{ mol } = 0.0639 \text{ moles}
\]

\[
0.0639 \text{ mol S}_8 \times \frac{256.56 \text{ g S}_8}{1 \text{ mol S}_8} = 16.4 \text{ g S}_8 \text{ excess}
\]

7. Given the following equation: \(\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu(NO}_3)_2 + 2\text{Ag}\)

a. How many moles of \(\text{Cu}\) are needed to react with 3.50 moles of \(\text{AgNO}_3\)?

\[
3.50 \text{ mol} \times \frac{1 \text{ mol Cu}}{2 \text{ mol AgNO}_3} = 1.75 \text{ mol Cu}
\]

b. If \(2.346 \times 10^{-3} \text{ mol}\) of copper react, how many atoms of silver are produced?

\[
2.346 \times 10^{-3} \text{ mol} \times \frac{2 \text{ mol Ag}}{1 \text{ mol Cu}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol Ag}} = 2.826 \times 10^{21} \text{ Ag atoms}
\]
8. Molten iron and carbon monoxide are produced in a blast furnace by the reaction of iron(III) oxide and coke (pure carbon). If 25.0 kilograms of pure Fe₂O₃ is used, how many kilograms of iron can be produced? The reaction is:

\[
\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}
\]

\[
25.0 \text{ kg Fe}_2\text{O}_3 \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol} \text{Fe}_2\text{O}_3}{159.70 \text{ g}} \times \frac{2 \text{ mol} \text{Fe}}{1 \text{ mol} \text{Fe}_2\text{O}_3} \times \frac{55.85 \text{ g} \text{Fe}}{1 \text{ mol} \text{Fe}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 17.5 \text{ kg Fe}
\]

9. The average human requires 120.0 grams of glucose (C₆H₁₂O₆) per day. How many grams of CO₂ (in the photosynthesis reaction below) are required to produce this amount of glucose?

\[
6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

\[
120.0 \text{ g} \text{C}_6\text{H}_{12}\text{O}_6 \times \frac{1 \text{ mol} \text{C}_6\text{H}_{12}\text{O}_6}{180.16 \text{ g} \text{C}_6\text{H}_{12}\text{O}_6} \times \frac{6 \text{ mol} \text{CO}_2}{4 \text{ mol} \text{C}_6\text{H}_{12}\text{O}_6} \times \frac{44.01 \text{ g} \text{CO}_2}{1 \text{ mol} \text{CO}_2} = 175.9 \text{ g} \text{CO}_2
\]

10. Given the reaction: 4\text{NH}_3(g) + 5\text{O}_2(g) \rightarrow 4\text{NO}(g) + 6\text{H}_2\text{O}(l)

a. If 23.55 g of ammonia react, how many grams of nitrogen monoxide are produced?

\[
23.55 \text{ g} \text{NH}_3 \times \frac{1 \text{ mol} \text{NH}_3}{17.03 \text{ g} \text{NH}_3} \times \frac{4 \text{ mol} \text{NO}}{4 \text{ mol} \text{NH}_3} \times \frac{30.01 \text{ g} \text{NO}}{1 \text{ mol} \text{NO}} = 41.50 \text{ g NO}
\]

b. How many grams of water are produced?

\[
23.55 \text{ g} \text{NH}_3 \times \frac{1 \text{ mol} \text{NH}_3}{17.03 \text{ g} \text{NH}_3} \times \frac{6 \text{ mol} \text{H}_2\text{O}}{4 \text{ mol} \text{NH}_3} \times \frac{18.02 \text{ g} \text{H}_2\text{O}}{1 \text{ mol} \text{H}_2\text{O}} = 37.38 \text{ g H}_2\text{O}
\]

c. How many grams of oxygen are required to react all of the ammonia?

\[
23.55 \text{ g} \text{NH}_3 \times \frac{1 \text{ mol} \text{NH}_3}{17.03 \text{ g} \text{NH}_3} \times \frac{5 \text{ mol} \text{O}_2}{4 \text{ mol} \text{NH}_3} \times \frac{32.00 \text{ g} \text{O}_2}{1 \text{ mol} \text{O}_2} = 55.31 \text{ g O}_2
\]