1. Match the following laws to the correct experiment:
   a) conservation of mass
   b) definite proportions
   c) multiple proportions
   i) water always contains a ratio of 1 g hydrogen to 8 g of water
   ii) in a reaction, the weight of product were found to equal weight of reactants
   iii) the following compounds were found to exist: NO, NO₂, N₂O

2. Which of the following is not a part of Dalton’s Atomic Theory?
   a) elements are made of atoms
   b) atoms of a given element are identical
   c) compounds are formed when atoms of different elements combine
   d) chemical reactions reorganize atoms by changing the way they are bonded together
   e) chemical reactions change atoms of one element into another element

3. Copper consists of two isotopes: $^{63}$Cu and $^{65}$Cu. If the average atomic mass of copper is 63.546 amu, what are the relative abundances of the two copper isotopes?

   \[
   63.546 = 63(x) + 65(y) \quad x + y = 1
   \]

   \[
   63.546 = 63x + 65(1-x) \quad \Rightarrow \quad x = 0.73 \quad y = 1 - 0.73 = 0.27
   \]

   \[
   \begin{align*}
   63.546 & = 37.1 \text{ amu} \quad 63\text{Cu}, \\
   6.45 & = 27\text{ amu} \quad 65\text{Cu}
   \end{align*}
   \]

4. Calculate the following:
   a. the mass in grams of 0.386 moles of aluminum hydroxide
      \[
      0.386 \text{ mol Al(OH)}_3 \left( \frac{78.9 \text{ g}}{\text{mol}} \right) = \boxed{30.1 \text{ g}}
      \]
   b. the number of molecules in 1.00 g of glucose, C₆H₁₂O₆
      \[
      1.00 \text{ g C₆H₁₂O₆} \left( \frac{1 \text{ mol}}{180.1 \text{ g}} \right) \left( 6.022 \times 10^{23} \text{ molecules/mol} \right) = \boxed{3.35 \times 10^{21} \text{ molecules}}
      \]
   c. the mass in grams of 2.50 x 10¹⁸ molecules of ammonia, NH₃
      \[
      2.50 \times 10^{18} \text{ molecule} \left( \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecule}} \right) \left( \frac{17.0 \text{ g}}{\text{mol}} \right) = \boxed{7.1 \times 10^{-5} \text{ g}}
      \]
   d. the number of lead atoms in 0.052 g of Pb₃(PO₄)₂
      \[
      0.052 \text{ g} \left( \frac{1 \text{ mol}}{811.5 \text{ g}} \right) \left( 6.022 \times 10^{23} \text{ molecule/mol} \right) \left( \frac{3 \text{ Pb atoms}}{1 \text{ molecule}} \right) = \boxed{1.2 \times 10^{20} \text{ Pb atoms}}
      \]

5. Calculate the mass percent of phosphorous in magnesium phosphate.

   \[
   \text{Mg}_3(\text{PO}_4)_2
   \]

   \[
   \% P = \frac{2 \times 30.97}{3 \times 24.3 + 2 \times 30.97 + 8 \times 16.0} \times 100 = \boxed{23.6\%}
   \]
6. Caffeine contains 49.5% C, 5.15% H, 28.9% N, and 16.5% O by mass. If the molar mass of caffeine is 195 g/mole, determine the empirical and molecular formulas of caffeine.

\[
\begin{align*}
49.5 \text{ g C} \left( \frac{\text{mol}}{125} \right) &= 4.13 \text{ mol} / 103 = 4 \quad \text{[C}_4\text{H}_5\text{N}_2\text{O}_2\text{]} \quad \text{empirical formula} \\
5.15 \text{ g H} \left( \frac{\text{mol}}{1} \right) &= 5.15 \text{ mol} / 103 = 5 \\
28.9 \text{ g N} \left( \frac{\text{mol}}{14} \right) &= 2.06 \text{ mol} / 103 = 2 \\
16.5 \text{ g O} \left( \frac{\text{mol}}{16} \right) &= 1.03 \text{ mol} / 103 = 1 \\
\end{align*}
\]

\[
\frac{195}{97} = 2 \quad \text{[C}_8\text{H}_{10}\text{N}_4\text{O}_2\text{]} \quad \text{molecular formula}
\]

7. Given the reaction: \( 5 \text{ SF}_4 + 2 \text{ I}_2\text{O}_5 \rightarrow 4 \text{ IF}_5 + 5 \text{ SO}_2 \).
   a. Balance the above reaction.
   b. If 10.0 g \( \text{SF}_4 \) and 10.0g \( \text{I}_2\text{O}_5 \) react, which is the limiting reactant?
   \[
   \begin{align*}
   10 \text{ g SF}_4 \left( \frac{1 \text{ mol}}{108.19} \right) \left( \frac{4 \text{ mol IF}_5}{5 \text{ mol SF}_4} \right) &= 0.694 \text{ mol IF}_5 \\
   10 \text{ g I}_2\text{O}_5 \left( \frac{1 \text{ mol}}{333.89} \right) \left( \frac{4 \text{ mol IF}_5}{2 \text{ mol I}_2\text{O}_5} \right) &= 0.060 \text{ mol IF}_5 \quad \text{I}_2\text{O}_5 \text{ is LR}
   \end{align*}
   \]
   c. Calculate the mass of \( \text{IF}_5 \) produced.
   \[
   0.060 \text{ mol IF}_5 \left( \frac{222.5 \text{ g}}{1 \text{ mol}} \right) = 13.3 \text{ g IF}_5
   \]
   d. If 10.0 g \( \text{IF}_5 \) are collected, calculate the percent yield.
   \[
   \% \text{ yield} = \frac{10 \text{ g}}{13.3 \text{ g}} \times 100 = 75.2\%
   \]

8. Consider the following reaction. If a container were to have 10 molecules of \( \text{O}_2 \) and 10 molecules of \( \text{NH}_3 \) initially, how many total molecules would be present in the container after this reaction goes to completion?

\[
\begin{align*}
4 \text{ NH}_3(g) + 5 \text{ O}_2(g) &\rightarrow 4 \text{ NO}(g) + 6 \text{ H}_2\text{O}(g) \\
10 \text{ molec O}_2 \left( \frac{4 \text{ NO}}{5 \text{ O}_2} \right) &= 8 \text{ molec NO} \quad \text{(O}_2 \text{ is LR)} \\
10 \text{ molec NH}_3 \left( \frac{4 \text{ NO}}{4 \text{ NH}_3} \right) &= 10 \text{ molec NO} \\
10 \text{ molec O}_2 \left( \frac{6 \text{ H}_2\text{O}}{5 \text{ O}_2} \right) &= 12 \text{ molec H}_2\text{O} \\
\end{align*}
\]

9. How many grams of fluorine are needed to produce 83g of \( \text{PF}_3 \) if the reaction has a 63% yield?

\[
\text{P}_4 + 6 \text{ F}_2 \rightarrow 4 \text{ PF}_3
\]

\[
\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100
\]

\[
63 = \frac{83 \text{ g PF}_3}{x} \times 100
\]

\[
x = \text{theoretical yield} = 132 \text{ g PF}_3
\]

\[
132 \text{ g PF}_3 \left( \frac{1 \text{ mol}}{88.5 \text{ g}} \right) \left( \frac{6 \text{ mol F}_2}{4 \text{ mol PF}_3} \right) \left( \frac{38 \text{ g F}_2}{\text{mol}} \right) = 85.5 \text{ g F}_2
\]