1. a. (4) What is the formula of ammonium nitrate?

   \[
   \text{NH}_4\text{NO}_3
   \]

   b. (4) What is the mass of one mole of methanol (CH}_3\text{OH}) ?

   \[
   12.01 + 4 \times 1.008 + 16.00 = 32.04 \text{ g/mol}
   \]

c. (4) How many protons and electrons does the Fe(II) ion have?

   26 protons, 24 electrons

d. (4) An element has been found to have a molar mass of about 40 g/mol. Write the name and the symbol of that element.

   Calcium (V) or Argon (Ar)

e. (4) Write the atomic symbols of the elements Chlorine, Phosphorus, Copper, and Sodium.

   Cl, P, Cu, Na
2. Write a balanced equation for each of the following reactions (it is not necessary to indicate the states of each substance):

a. (6) Burning of benzene \((C_6H_6)\) in excess oxygen

\[ 2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O \]

b. (6) Reaction of iron(III) oxide with carbon monoxide to give iron metal and carbon dioxide.

\[ Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2 \]

c. (6) Potassium dissolves in water to give potassium hydroxide and hydrogen gas.

\[ 2K + 2H_2O \rightarrow 2KOH + H_2 \]

d. (6) Nitrogen gas and hydrogen gas react to form ammonia (NH\(_3\)).

\[ N_2 + 3H_2 \rightarrow 2NH_3 \]

3. (10) A substance that contains C, H, and O is subjected to combustion analysis. 50.0 g of the substance is burned to produce 61.4 g of carbon dioxide and 22.6 g of water. What is the percent composition of this substance?

Molar mass of CO\(_2\) : \(12.01 + 2 \times 16.00 = 44.01\) g/mol

Molar mass of H\(_2\)O : \(16.00 + 2 \times 1.008 = 18.02\) g/mol

\[ \begin{align*}
61.4 \text{ g CO}_2 & \times \frac{12.01 \text{ g C}}{44.01 \text{ g CO}_2} = 16.8 \text{ g C} \\
22.6 \text{ g H}_2\text{O} & \times \frac{2.016 \text{ g H}}{18.02 \text{ g H}_2\text{O}} = 2.53 \text{ g H}
\end{align*} \]

Oxygen : \(50.0 - 16.8 - 2.53 = 30.7\) g O

Percent composition:

\[ \begin{align*}
\text{C} : & \quad 16.8/50.0 \times 100\% = 33.6\% \\
\text{H} : & \quad 2.53/50.0 \times 100\% = 5.06\% \\
\text{O} : & \quad 30.7/50.0 \times 100\% = 61.4\%
\end{align*} \]
4. The percent composition of glucose is 40.0 % C, 6.7 % H, and 53.3 % O.

a. (10) What is the empirical formula of glucose?

Consider 100 g of sample. In this we have 40.0 g C, 6.7 g H, and 53.3 g O
Find number of moles:
C: 40.0 g / (12.01 g/mol) = 3.33 mol
H: 6.7 g / (1.008 g/mol) = 6.65 mol
O: 53.3 g / (16.00 g/mol) = 3.33 mol

Divide by the smallest: The whole-number ratio is C:H:O = 1:2:1

Therefore empirical formula is CH₂O

b. (5) The molar mass of glucose is 180.16 g/mol. What is its molecular formula?

Molar mass of CH₂O unit is 12.01 + 2 X 1.008 + 16.00 = 30.03 g/mol

180.16/30.03 = 6

Therefore, molecular formula is C₆H₁₂O₆

5. (10) You are given a sample of metal A and a sample of metal B of equal masses. A has a density of 3.2 g/mL and B has a density of 9.6 g/mL. If the sample of metal A has a volume of 7.5 mL, what is the volume of the sample of metal B?

mass = density X volume = 3.2 g/mL X 7.5 mL

Volume of B = mass/density = 3.2 X 7.5 g / (9.6 g/mL) = 2.5 mL
6. (16) Sodium silicate reacts with hydrofluoric acid in the following way:

\[ \text{Na}_2\text{SiO}_3 (s) + 8\text{HF} (aq) \rightarrow \text{H}_2\text{SiF}_6 (aq) + 2\text{NaF} (aq) + 3\text{H}_2\text{O} (l) \]

a. (5) A reacting mixture contains 3.0 moles of HF and 2.0 moles of Na\(_2\)SiO\(_3\). Which one is the limiting reactant?

2 moles Na\(_2\)SiO\(_3\) require 16 moles HF.
We only have 3 moles of HF.
Therefore: HF is the limiting reactant

b. (11) How many grams of NaF will be produced by the above reacting mixture?

All of HF will react.

Molar mass of NaF : 22.99 + 19.00 = 41.99 g/mol

\[
3.0 \text{ moles HF} \times \frac{2 \text{ moles NaF}}{8 \text{ moles HF}} \times \frac{41.99 \text{ g NaF}}{\text{mole NaF}} = 31 \text{ g NaF}
\]

7. (5) How many grams of glucose do you need to dissolve in 100 mL of water to make a solution of molarity 3.00 M? The molar mass of glucose is 180.2 g/mol.

\[
3.00 \text{ mol/L} \times 0.100 \text{ L} \times 180.2 \text{ g/mol} = 54.1 \text{ g}
\]