Chemistry 11 : Empirical and Molecular Formulae

1. When 0.224 g of tin, reacted with an excess of chlorine, 0.492 g of a tin chloride salt was obtained. What is the empirical formula of the salt?

mass $Cl = 0.492g - 0.224g = 0.268g$

mols $Sn = 0.224g \div 118.7 g/mol = 1.89 \times 10^{-3}$ mol

mols $Cl = 0.268g \div 35.5 g/mol = 7.55 \times 10^{-3}$ mol

Ratio $Sn : Cl$

$= \dfrac{1.89 \times 10^{-3} : 7.55 \times 10^{-3}}{1.89 \times 10^{-3} : 1.89 \times 10^{-3}}$

$= 1 : 4$

The empirical formula is $SnCl_4$

2. When 0.445 g of potassium reacted with excess oxygen, 0.809 g of a yellow oxide was obtained. What is the empirical formula of the oxide?

mass $O = 0.809g - 0.445g = 0.364g$

mols $k = 0.445g \div 39.1 g/mol = 1.14 \times 10^{-2}$ mol

mols $O = 0.364g \div 16.0 g/mol = 2.28 \times 10^{-2}$ mol

Ratio $k : O$

$= \dfrac{1.14 \times 10^{-2} : 2.28 \times 10^{-2}}{1.14 \times 10^{-2} \quad 1.14 \times 10^{-2}}$

$= 1 : 2$

The empirical formula is KO_2

3. Find the empirical formula of a compound that is 34.43% iron and 65.57% chlorine. Assume 100 g Sample

mass $Fe = 34.43\%$ of $100g = 34.43g$

moles $Fe = 34.43g \div 55.8 g/mol = 0.617$ mol Fe

mass $Cl = 65.57\%$ of $100 = 65.57g$

moles $Cl = 65.57g \div 35.5 g/mol = 1.85$ mol Cl

Ratio $Fe : Cl$

$= \dfrac{0.617}{0.617} : \dfrac{1.85}{0.617}$

$= 1 : 3$

The empirical formula is $FeCl_3$

4. Find the empirical formula of a compound that is 63.5% carbon, 12.2% hydrogen, and 24.2% oxygen. Assume 100 g sample

mol $C = 63.5g \div 12.0 g/mol = 5.29$ mol

mol $H = 12.2g \div 1.0 g/mol = 12.2$ mol

mol $O = 24.2g \div 16.0 g/mol = 1.51$ mol

Ratio $C : H : O$

$= \dfrac{5.29}{1.51} : \dfrac{12.2}{1.51} : \dfrac{1.51}{1.51}$

$= 3.5 : 8 : 1$ or $7 : 16 : 2$

The empirical formula is $C_7H_{16}O_2$

5. The empirical formula of cyclohexane is CH_2, and its molar mass is 84.0 g/mol. What is the molecular formula of cyclohexane?

FW $CH_2 = 12.0u + 2(1.0u) = 14.0 u = 14.0 g/mol$

of $CH_2 = \dfrac{84.0 g/mol}{14.0 g/mol} = 6$ molecular formula is $C_6H_{2(6)} = C_6H_{12}$

6. Adipic acid, used to make some types of nylon, has the empirical formula C_3H_5O. Its molar mass is 114.0 g. What is the molecular formula of adipic acid?

FW $C_3H_5O = 3(12.0u) + 5(1.0u) + 16.0u = 57.0 g/mol$

of $C_3H_5O = \dfrac{114.0 g/mol}{57.0 g/mol} = 2$ $C_{3(2)}H_{5(2)}O_2 = C_6H_{10}O_2$