Humza Khokhar Unit 3 activity 3

1. $Al_2(SO_4)_3$

Given

M of Al = 26.982 g/mol

M of S = 32.066 g/mol

M of O = 15.999 g/mol

n# of Al = 2

n# of S = 3

n# of O = 4(3) = 12

Required

% Al = ?

% S = ?

% O = ?

$$M \text{ of } Al_2(SO_4)_3 = (M \text{ of } Al)2 + (M \text{ of } S)3 + (M \text{ of } O)12 \text{ g/mol}$$

$$= 26.982(2) + 32.066(3) + 15.999(12) \text{ g/mol}$$

$$= 342.15 \text{ g/mol}$$

Solution

$$\% \text{ element} = \frac{n \times M_{element}}{M_{compound}} \times 100\%$$

$$\% Al = \frac{2 \times 26.982 \text{ g/mol}}{342.15 \text{ g/mol}} \times 100\%$$

$$= 15.77203 \doteq 15.77\%$$

$$\% S = \frac{3 \times 32.066 \text{ g/mol}}{342.15 \text{ g/mol}} \times 100\%$$

$$= 28.115739 \doteq 28.12\%$$

$$\% O = \frac{12 \times 15.999 \text{ g/mol}}{342.15 \text{ g/mol}} \times 100\%$$

$$= 56.112231 \doteq 56.11\%$$

∴ The percent composition of mass by Aluminum, sulfur & oxygen are:

Al: 15.77%

S: 28.12%

O: 56.11%

2. Assume total mass of 100 grams

Given

$m_{Na} = 32.4 g$ Na

$m_S = 22.5 g$ S

$m_O = 45.1 g$ O

$M_{Na} = 22.990 g/mol$

$M_S = 32.066 g/mol$

$M_O = 15.999 g/mol$

Required

Empirical Formula

$NaSO = ?$

$n_{Na} = ?$

$n_S = ?$

$n_O = ?$

Solution

$$n_{Na} = \frac{m_{Na}}{M_{Na}} = \frac{32.4 g}{22.990 g/mol} = 1.409308395 \text{ mol} \doteq 1.41 \text{ mol Na}$$

$$n_S = \frac{m_S}{M_S} = \frac{22.5 g}{32.066 g/mol} = 0.7016777896 \text{ mol} \doteq 0.70 \text{ mol S}$$

$$n_O = \frac{m_O}{M_O} = \frac{45.1 g}{15.999 g/mol} = 2.818926183 \text{ mol} \doteq 2.82 \text{ mol O}$$

	Na	S	O
	1.41	0.70	2.82
Divide by lowest mole value, 0.70 mol	2.01	1	4.03
Rounded	2	1	4

∴ the empirical formula is Na_2SO_4

3. Assume a 100 g sample

Given

$m_C = 64.9\,g\ C$ $\quad M_C = 12.011\ g/mol$

$m_H = 13.5\,g\ H$ $\quad M_H = 1.008\ g/mol$ $\quad M_{compound} = 74.14\ g/mol$

$m_O = 21.6\,g\ O$ $\quad M_O = 15.999\ g/mol$

Required

Molecular Formula for CHO

$n_C = ?$

$n_H\ ?$

$n_O\ ?$

Solution

$$n_C = \frac{m_C}{M_C} = \frac{64.9\,g}{12.011\,g/mol} = 5.40338024\ldots \text{ mol} \doteq 5.40 \text{ mol C}$$

$$n_H = \frac{m_H}{M_H} = \frac{13.5\,g}{1.008\,g/mol} = 13.39285714 \text{ mol} \doteq 13.39 \text{ mol H}$$

$$n_O = \frac{m_O}{M_O} = \frac{21.6}{15.999} = 1.35008438 \text{ mol} \doteq 1.35 \text{ mol O}$$

Divide by lowest mole, 1.35mol

C	H	O
5.40	13.39	1.35
4	9.92	1
4	10	1

Empirical Formula is $C_4H_{10}O$

Empirical molar mass

$\hookrightarrow M_{C_4H_{10}O} = M_{C_4} + M_{H_{10}} + M_O$

$= 4(12.011) + 10(1.008) + 15.999$ g/mol

$= 74.123$ g/mol

Ratio $M_{compound}$ to $M_{C_4H_{10}O}$

$\hookrightarrow \frac{\text{Molecular mass}}{\text{Empirical Molar mass}} = \frac{74.14}{74.123} = 1.000229349$

$\doteq 1.00$

Ratio = 1.00 : 1

$\hookrightarrow$ Molecular Formula is the same as Empirical formula.

$\therefore$ The molecular Formula is $C_4H_{10}O$