Marks 4

- An unknown compound contains carbon and hydrogen only. If 0.0956 g of the compound is burned in oxygen, 0.300 g of CO_2 and 0.123 g of H_2O are isolated. What is the unknown compound's empirical formula?

The molar mass of CO_2 is (12.01 (C)) + (2 × 16.00 (O)) = 44.01. The molar mass of H_2O is (2 × 1.008 (H)) + (16.00 (O)) = 18.016. The number of moles of each after burning is therefore:

$$n_{CO_2} = \frac{\text{mass}}{\text{molar mass}} = \frac{0.300}{44.01} = 0.00682\,\text{mol},\ n_{H_2O} = \frac{0.123}{18.016} = 0.00683\,\text{mol}$$

The moles of C in the compound is equal to the number of moles of CO_2, as the latter possesses one carbon atom per molecular unit.

The moles of H in the compound is equal to 2 × number of moles of H_2O, as the latter contains two hydrogen atoms per molecular unit.

The C:H ratio is therefore 1:2

Answer: **CH_2**

If its molar mass is found to be 70.1 g mol^{-1}, what is its molecular formula?

If the molar mass = 70.1, the number of moles in 0.0956 g is:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{0.0956}{70.1} = 0.00136\,\text{mol}$$

As 0.00136 mol contains 0.683 mol of carbon, 1 mol contains $\frac{0.00683}{0.00136} = 5.01\,\text{mol}$

As C:H is 1:2, the compound must contain 10 hydrogen atoms.

Answer: **C_5H_{10}**

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- What amount (in mol) of chloride ion is contained in 100 mL of 0.25 M magnesium chloride solution?

Magnesium chloride dissolves according to the equation, $MgCl_2(s) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$ so that two moles of chloride is produced for every mole of $MgCl_2$ present. The number of moles of $MgCl_2$ present is :

$$\text{number of moles} = \text{concentration} \times \text{volume} = 0.25 \times \frac{100}{1000} = 0.025\ \text{mol}$$

The number of moles of $Cl^-(aq)$ is therefore 2 × 0.025 = 0.050 mol

Answer: **0.050 mol**

- If 25.0 mL of 1.50 M hydrochloric acid is diluted to 500 mL, what is the molar concentration of the diluted acid?

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The number of moles of HCl present in 25.0 mL of a 1.50 M solution is:

$$\textbf{number of moles} = \textbf{concentration} \times \textbf{volume} = 1.50 \times \frac{25}{1000} = 0.0375 \text{ mol}$$

This number of moles in a 500 mL solution gives a concentration of:

$$\textbf{concentration} = \frac{\textbf{number of moles}}{\textbf{volume}} = \frac{0.0375}{(500/1000)} = 0.0750 \text{ M}$$

Answer: **0.0750 M**