

Basic Chemistry Concepts



Problems Based on Percentage Composition

Problem 1

Calculate the percentage composition of carbon in carbon dioxide (CO_2).

Problem 2

A sample of a compound contains 40% sulfur and 60% oxygen by mass. Determine the empirical formula of the compound.

Problem 3

Calculate the percentage composition of hydrogen in methane (CH_4).

Problem 4

Determine the percentage composition of nitrogen in ammonium nitrate (NH_4NO_3).

Problem 5

A compound is found to contain 70.0% iron (Fe) and 30.0% oxygen (O) by mass. Calculate the empirical formula of the compound.

Problem 6

Calculate the percentage composition of each element in glucose ($\text{C}_6\text{H}_{12}\text{O}_6$).

Answer Key

Problem 1

Percentage Composition of Carbon in CO_2 :

- Molar mass of $\text{CO}_2 = 12.01 (\text{C}) + 2 \times 16.00 (\text{O}) = 44.01 \text{ g/mol}$
- Mass of carbon in $\text{CO}_2 = 12.01 \text{ g}$
- Percentage of carbon:

$$\left(\frac{12.01}{44.01}\right) \times 100 \approx 27.29\%$$

Problem 2

Empirical Formula of the Compound with 40% Sulfur and 60% Oxygen:

- Assume 100 g of the compound: 40 g S, 60 g O
- Moles of S = $\frac{40}{32.07} \approx 1.25$ mol
- Moles of O = $\frac{60}{16.00} = 3.75$ mol
- Simplest ratio: 1.25 mol S : 3.75 mol O

Divide by 1.25 \Rightarrow 1 : 3

- Empirical formula: SO_3

Problem 3

Percentage Composition of Hydrogen in CH_4 :

- Molar mass of $\text{CH}_4 = 12.01$ (C) + 4×1.008 (H) = 16.042 g/mol
- Mass of hydrogen in $\text{CH}_4 = 4 \times 1.008 = 4.032$ g
- Percentage of hydrogen:

$$\left(\frac{4.032}{16.042}\right) \times 100 \approx 25.14\%$$

Problem 4

Percentage Composition of Nitrogen in NH_4NO_3 :

- Molar mass of $\text{NH}_4\text{NO}_3 = 2 \times 14.01$ (N) + 4×1.008 (H) + 3×16.00 (O) = 80.052 g/mol
- Mass of nitrogen in $\text{NH}_4\text{NO}_3 = 2 \times 14.01 = 28.02$ g
- Percentage of nitrogen:

$$\left(\frac{28.02}{80.052}\right) \times 100 \approx 35.00\%$$

Problem 5

Empirical Formula of the Compound with 70.0% Iron and 30.0% Oxygen:

- Assume 100 g of the compound: 70.0 g Fe, 30.0 g O
- Moles of Fe = $\frac{70.0}{55.85} \approx 1.25$ mol
- Moles of O = $\frac{30.0}{16.00} \approx 1.875$ mol
- Simplest ratio: 1.25 mol Fe : 1.875 mol O

Divide by 1.25 \Rightarrow 1 : 1.5

- Multiply by 2 to get whole numbers: 2 Fe : 3 O
- Empirical formula: Fe_2O_3

Problem 6

Percentage Composition of Each Element in $\text{C}_6\text{H}_{12}\text{O}_6$:

- Molar mass of $\text{C}_6\text{H}_{12}\text{O}_6 = 6 \times 12.01$ (C) + 12×1.008 (H) + 6×16.00 (O) = 180.156 g/mol

- Mass of carbon = $6 \times 12.01 = 72.06$ g
- Mass of hydrogen = $12 \times 1.008 = 12.096$ g
- Mass of oxygen = $6 \times 16.00 = 96.00$ g
- Percentage of carbon:

$$\left(\frac{72.06}{180.156}\right) \times 100 \approx 40.00\%$$

- Percentage of hydrogen:

$$\left(\frac{12.096}{180.156}\right) \times 100 \approx 6.71\%$$

- Percentage of oxygen:

$$\left(\frac{96.00}{180.156}\right) \times 100 \approx 53.29\%$$