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aliases: [percentage composition, empirical formula ]
tags: [GR10/Q4 chemistry/quantitative-chemistry ]
created: Sun 13/11 2022
modified: Sun 13/11 2022
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Law of Constant Composition

Law: All samples of a given chemical compound have the same elemental composition.

Explanation

This law states that the ratio's that elements will combine in will always be constant. For instance, water will always combine as:H_20. Because of this we can use the law of constant composition to find the percentage mass, percentage composition, and other numbers to do with Stoichiometry.

Percentage Mass

Using the law of constant composition and molar ratios found in formulae, we can use figure out the percentage mass of an element within a compound. This is done by working out the mass of 1 mol of the element, as well as the mass of the compound. Then we can use these two values to figure out the percentage that the mass of the element makes up the mass of the compound.

Formula

$$\text{Mass Percentage} = \frac{m_{\text{element}}}{m_{\text{compound}}} \times 100$$

Where:

$m =$ mass (g)

> mass

> [!example] Example: Find the Percentage mass
>
> Question: Find the Percentage mass of Na in 12g of Na_2O
>
> Answer:

$$\text{Mass Percentage} = \frac{m_{Na}}{m_{Na_2O}} \times 100$$
$$m_{Na} = n(M) = 1(23) = 23g$$
$$m_{Na_2O} = n(M) = 2(23) + 16 = 62g$$
$$\frac{23}{62} \times 100 = 37,09\% \approx 37\%$$

Percentage Composition

We can use the law of constant composition to find the empirical formula of a substance if we know the masses of the component elements of the substance. Percentage composition is percentage mass for each element in a compound.

This can be done by figuring out what percentage mass each element is of the substance, and then converting it into moles and finding the mole's of each substance. Then we can simplify these numbers of moles into mole ratios, and use that ratio as our empirical formula.

💡 Example: Percentage Composition

Question: A substance with 0,4026g was found containing 0,1610g of carbon, 0,0268g of hydrogen, and 0,2148g of oxygen

$$\textbf{Percentage Composition}$$
$$\%C = \frac{m_{\text{carbon}}}{0,4026g} \times 100 = \frac{0,1610g}{0,4026g} \times 100 \qquad = 40\%$$
$$\%H = \frac{m_{\text{hydrogen}}}{0,4026g} \times 100 = \frac{0,0268g}{0,4026g} \times 100 \qquad = 6.66\%$$
$$\%O = \frac{m_{\text{oxygen}}}{0,4026g} \times 100 = \frac{0,2148g}{0,4026g} \times 100 \qquad = 53,35\%$$