

Fundamental Chemical Laws

I. Law of Conservation of mass:

Mass cannot be created nor destroyed.

Reference:

Antoine Lavoisier – By carefully weighing the reactants & products of chemical reactions.

Learning Question:

A 0.406 g sample of magnesium reacts with oxygen, producing 0.674 g magnesium oxide as the only product. What mass of oxygen was consumed in the reaction?

II. Law of Definite Proportion:

A given compound always contains exactly the same proportion of elements by mass.

Reference:

Joseph Proust.

Example:

10.000 g of water gives 1.119 g of hydrogen gas and 8.881 g of oxygen gas. Also 27.000 g of water produces 3.021 g hydrogen and 23.979 g oxygen. How it shows the law of definite proportions?

Solution:

$$\frac{1.119 \text{ g of Hydrogen}}{10.000 \text{ g of water}} \times 100 = 11.19 \% H$$

$$100 - 11.19 = 88.81\% \text{ Oxygen}$$

$$\frac{3.021 \text{ g of Hydrogen}}{27.000 \text{ g of water}} \times 100 = 11.19 \% H$$

$$100 - 11.19 = 88.81\% \text{ Oxygen}$$

∴ The results of two different measurements show same composition of water.

Learning Question:

3.06 g of hydrogen react with oxygen where 27.35 g of water are obtained. In a second experiment, water is decomposed resulting in 1.45 g of hydrogen and 11.51 g of oxygen. Is this consistent with the law of definite proportions?

III. Law of multiple proportions:

When two elements (A & B) form a series of compounds (AB_1 , AB_2 , AB_3 ...), the ratios of the masses of the second element (B) that combine with a fixed mass of the first element (A) can always be reduced to small whole numbers as $(\frac{B_1}{B_2}, \frac{B_1}{B_3}, \frac{B_2}{B_3}, \dots)$

Reference:

John Dalton (The 3rd postulate of his atomic theory).

Example:

The nitrogen and oxygen forming three different compounds that contain different relative amounts of nitrogen and oxygen. One gram oxygen combines with the following mass of nitrogen:

Compound A	1.750	g Nitrogen
Compound B	0.8750	g Nitrogen
Compound C	0.4375	g Nitrogen

Solution:

$$\frac{A}{B} = \frac{1.750 \text{ g}}{0.8750 \text{ g}} = 2 \quad ; \quad \frac{B}{C} = \frac{0.8750 \text{ g}}{0.4375 \text{ g}} = 2 \quad ; \quad \frac{A}{C} = \frac{1.750 \text{ g}}{0.4375 \text{ g}} = 4$$

$\therefore$ For the one gram oxygen, the ratios of the masses of nitrogen show small whole integer number.

Learning Question:

Which of the following pairs of compounds can be used to illustrate the “law of multiple proportions”?

