1.3 – Chemical Equations

1.3.1 - Deduce chemical equations when all the reactants and products are given

Chemical formulas are shorthand representations of compounds. **Chemical reactions** are represented by equations using the chemical formulas and symbols of the substances involved in the reaction.

$$\text{methane} + \text{oxygen} \longrightarrow \text{carbon dioxide} + \text{water}$$

$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

This equation is more informative than the first. However, when writing out these reactions, we must take into account the Law of Conservation.

The Law of Conservation is that matter can neither be created nor destroyed, it can only be changed from one form into another. In the case of chemical equations, this means that there must be the same number of every type of atom on both sides of the equation. All that happens in a chemical reaction is that the bonds in the reactants break, the atoms rearrange, and bonds between the products are formed. Therefore, to reflect this, all chemical equations must be **balanced**. We do this by adding **integer coefficients** to the chemical formulas, except, of course, in the case of 1.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

1.3.2 - Identify the mole ratio of any two species in a chemical equation

Once we have balanced any chemical equation, we are able to determine the **molar ratio** of the various species in it. For example:

$$Li_2O_{(s)} + 2HCl_{(aq)} \longrightarrow 2LiCl_{(aq)} + H_2O_{(l)}$$

From this equation we can see that one mole of lithium oxide reacts with two mole of hydrochloric acid to produce two mole of lithium chloride and one mole of water.

An equation shows that one mole of gaseous methane molecules combines with two mole of gaseous oxygen molecules, producing one mole of gaseous carbon dioxide and two mole of gaseous water molecules. The equation shows the ratio of reactants and products to each other. The coefficients in the equation can be shown as a ratio:

$$CH_4 : O_2 : CO_2 : H_2O$$

$$1 : 2 : 1 : 2$$

1.3.3 - Apply the state symbols (s), (l), (g) and (aq)

We can balance equations by looking at each type of atom in turn. The balanced equation for the combustion of methane is:

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

We can add symbols to how the physical states of the reactants and products. This is the final step in equation writing. These are:

(g) - gas

(l) - liquid

(s) - solid

(aq) - aqueous (in solution)

These symbols represent the state of each substance at room temperature, unless otherwise specified. Therefore, we would end up with:

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$$

All the molecules in this reaction are in the gaseous state.