Stoichiometry

Stoichiometry is the process of determining how much product is made or how much reactant is needed during a chemical reaction. As we know, in chemical reactions **atoms are conserved**. We show this in a balanced chemical equation.

The balanced chemical equation tells us two things:

1. Reactants and products involved in the chemical change (rearrangement of atoms).
2. The ratio of particles involved. This ratio can be seen either as a ratio of individual particles or as a ratio of moles.

In lab, it is only practical to work with moles of substances rather than individual atoms or molecules, and so we interpret our equations as a ratio of moles, or a **mole ratio**.

Example: $2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$

For the reaction above, we would interpret the balanced chemical equation as:

For every 2 moles of Mg that reacts, 1 mole of O_2 is required and 2 moles of MgO are produced.

Thus, the mole ratio is: **2 moles Mg : 1 mole O_2 : 2 moles of MgO**

The mole ratio relationship can be used to make predictions about how much reactant is needed to make a specific amount of product or how much product can be made from the available amount of reactant.

Making Predictions

In every reaction, there are three stages to consider:

1. **Before:** amounts of each substance present before the reaction takes place.
2. **Change:** how much of each substance actually changes during the reaction.
3. **After:** amounts of each substance present after the reaction takes place.

These three stages will be organized into a Before-Change-After (BCA) table.

Sample Problem 1:

How many moles of H_2 are produced when 0.4 moles of CaH_2 react?

$$CaH_2 + 2\ H_2O \rightarrow Ca(OH)_2 + 2\ H_2$$

Before:

Change:

After:

Sample Problem 2:

$$3\ Li_2S\ +\ 2\ AlCl_3\ \rightarrow\ 6\ LiCl\ +\ Al_2S_3$$

a) How many moles of LiCl and Al_2S_3 are made when 6.3 moles of Li_2S react?

b) How many moles of LiCl and Al_2S_3 are produced when 2.2 moles of $AlCl_3$ react?

Sample Problem 3:

$$Fe_2O_3\ +\ 3\ C\ \rightarrow\ 2\ Fe\ +\ 3\ CO$$

a) How many moles of Fe_2O_3 and C are required to produce 9.0 moles of CO?

b) How many moles of Fe are made when 12 moles of C react?

Sample Problem 4:

How many grams of NH_3 will be produced when 4.2 moles of H_2 react?

$$N_2\quad +\quad 3\ H_2\quad \rightarrow\quad 2\ NH_3$$

Summary:

Stoichiometry Practice Problems

Practice Problem 1:

$$Ca(OH)_2 + 2\ HCl \rightarrow 2\ H_2O + CaCl_2$$

a) How many moles of $Ca(OH)_2$ are required to react with 6.4 moles of HCl?
b) How many moles of HCl are required to produce 3.5 moles of H_2O?
c) How many moles of $Ca(OH)_2$ are required to produce 12 moles of H_2O?

Practice Problem 2:

$$2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$$

a) How many moles of O_2 are required to produce 8.2 moles of H_2O?
b) How many moles of H_2O are produced when 10.5 moles of O_2 react?
c) How many moles of C_2H_2 are required to produce 3.6 moles of H_2O?
d) How many molecules of CO_2 are produced when 7.4 moles of C_2H_2 burn completely in oxygen?

Practice Problem 3:

$$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

a) If 12 moles of carbon dioxide are formed, how many moles of C_3H_8 (propane) were burned?
b) If 2.33 moles of C_3H_8 are burned, how many grams of CO_2 are made?
c) How much oxygen is required to react with 3.01 moles of C_3H_8?
d) How many liters of CO_2 are produced when 4.2 moles of C_3H_8 burn in excess O_2 at STP?

Practice Problem 4:

$$2\ AgNO_2(aq) + MgBr_2(aq) \rightarrow 2\ AgBr(s) + Mg(NO_3)_2(aq)$$

a) How many moles of $MgBr_2$ are required to react completely with 3.55 moles of $AgNO_3$?
b) If 3.13 moles of $MgBr_2$ react completely with excess $AgNO_3$, how many grams of AgBr are formed?
c) To produce 1.98 moles of AgBr, how many grams of $MgBr_2$ are needed?