Stoichiometry

Stoichiometry is the study of the relationships that exist in a balanced chemical equation.

Using conversion and the mole concept it is possible to make many predictions about the relationships between different reactants and products

eg

N_2 +	$3H_2$ ➜	$2NH_3$
1 molec	3 molec	2 molec
2 molec	6 molec	4 molec
3 molec	9 molec	6 molec
10 molec	30 molec	20 molec
1 mol	3 mol	2 mol
6.022×10^{23} molec	18.07×10^{23} molec	12.04×10^{23} molec
5 mol	15 mol	10 mol
8 mol	24 mol	16 mol
0.385 mol	1.155 mol	0.770 mol

These relationships can be achieved using conversions:

$$0.385 \text{ mol } N_2 \text{ x } \frac{3 \text{ mol } H_2}{1 \text{ mol } N_2} = 1.155 \text{ mol } H_2$$

$$1.155 \text{ mol } H_2 \text{ x } \frac{2 \text{mol } NH_3}{3 \text{mol } H_2} = 0.770 \text{ mol } NH_3$$

- the stoichiometic coefficients in the balanced chemical equation are used to provide mol to mol relationships
- this is the only time that you may have a number in front of mol other than 1

eg Determine the mass of sodium phosphate required to produce 13.8 g of calcium phosphate through the following balance chemical equation

$$\underset{(?\ g)}{2Na_3PO_4} + 3Ca(NO_3)_2 \rightarrow \underset{(13.8\ g)}{Ca_3(PO_4)_2} + 6NaNO_3$$

$$13.8\ g\ Ca_3(PO_4)_2 \times \frac{1\ mol\ Ca_3(PO_4)_2}{310.18 g\ Ca_3(PO_4)_2} \times \frac{2\ mol\ Na_3PO_4}{1\ mol\ Ca_3(PO_4)_2} \times \frac{163.94\ g\ Na_3PO_4}{1\ mol\ Na_3PO_4} = 14.6\ g\ Na_3PO_4$$

eg Determine the mass of iron(II) sulphide that is required to make 25.5 g of iron(III) oxide

$$\underset{(?\ g)}{4FeS} + 7O_2 \rightarrow \underset{(25.5\ g)}{2Fe_2O_3} + 4SO_2$$

$$25.5\ g\ Fe_2O_3 \times \frac{1\ mol\ Fe_2O_3}{159.70\ g\ Fe_2O_3} \times \frac{4\ mol\ FeS}{2\ mol\ Fe_2O_3} \times \frac{87.95\ g\ FeS}{1\ mol\ FeS} = 28.1\ g\ FeS$$

eg Determine the mass of oxygen produced by the thermal decomposition of 40.0 g of potassium chlorate.

$$\underset{(40.0\ g)}{2KClO_3} \rightarrow 2KCl + \underset{(?\ g)}{3O_2}$$

$$40.0\ g\ KClO_3 \times \frac{1\ mol\ KClO_3}{122.55\ g\ KClO_3} \times \frac{3\ mol\ O_2}{2\ mol\ KClO_3} \times \frac{32.00\ g\ O_2}{1\ mol\ O_2} = 15.7\ g\ O_2$$

eg Determine the mass in t (tonnes) of water formed from 35.0 t of ammonia in the following reaction

$$\underset{(35.0\ t)}{4NH_3} + 5O_2 \rightarrow 4NO + \underset{(?\ t)}{6H_2O}$$

1 t = 1000 kg and 1 kg = 1000 g

$$35.0\ t\ NH_3 \times \frac{1000\ kg\ NH_3}{1\ t\ NH_3} \times \frac{1000\ g\ NH_3}{1\ kg\ NH_3} \times \frac{1\ mol\ NH_3}{17.04\ g\ NH_3}$$

$$\times \frac{6\ mol\ H_2O}{4\ mol\ NH_3} \times \frac{18.02\ g\ H_2O}{1\ mol\ H_2O} \times \frac{1\ kg\ H_2O}{1000\ g\ H_2O} \times \frac{1\ t\ H_2O}{1000\ kg\ H_2O}$$

$$= 55.5\ t\ H_2O$$