

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	+	$3H_2$	\rightarrow	$2NH_3$
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

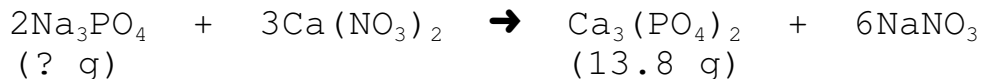
These relationships can be achieved using conversions:

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

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

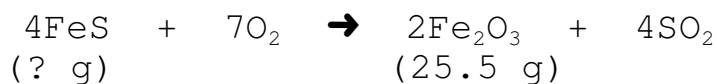
- the stoichiometric coefficients in the balanced chemical equation are used to provide mol to mol relationships
- this is the only time that you may have a number in front of mol other than 1

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



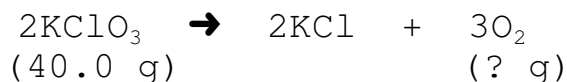
$$13.8 \text{ g Ca}_3(\text{PO}_4)_2 \times \frac{1 \text{ mol Ca}_3(\text{PO}_4)_2}{310.18 \text{ g Ca}_3(\text{PO}_4)_2} \times \frac{2 \text{ mol Na}_3\text{PO}_4}{1 \text{ mol Ca}_3(\text{PO}_4)_2} \times \frac{163.94 \text{ g Na}_3\text{PO}_4}{1 \text{ mol Na}_3\text{PO}_4} = 14.6 \text{ g Na}_3\text{PO}_4$$

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



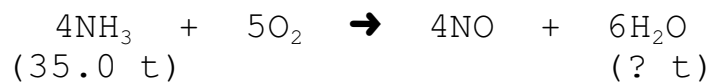
$$25.5 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.70 \text{ g Fe}_2\text{O}_3} \times \frac{4 \text{ mol FeS}}{2 \text{ mol Fe}_2\text{O}_3} \times \frac{87.95 \text{ g FeS}}{1 \text{ mol FeS}} = 28.1 \text{ g FeS}$$

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



$$40.0 \text{ g KClO}_3 \times \frac{1 \text{ mol KClO}_3}{122.55 \text{ g KClO}_3} \times \frac{3 \text{ mol O}_2}{2 \text{ mol KClO}_3} \times \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = 15.7 \text{ g O}_2$$

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



1 t = 1000 kg and 1 kg = 1000 g

$$\begin{aligned} & 35.0 \text{ t NH}_3 \times \frac{1000 \text{ kg NH}_3}{1 \text{ t NH}_3} \times \frac{1000 \text{ g NH}_3}{1 \text{ kg NH}_3} \times \frac{1 \text{ mol NH}_3}{17.04 \text{ g NH}_3} \\ & \times \frac{6 \text{ mol H}_2\text{O}}{4 \text{ mol NH}_3} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} \times \frac{1 \text{ kg H}_2\text{O}}{1000 \text{ g H}_2\text{O}} \times \frac{1 \text{ t H}_2\text{O}}{1000 \text{ kg H}_2\text{O}} \\ & = 55.5 \text{ t H}_2\text{O} \end{aligned}$$