Example:

How many milliliters of 6.00M hydrochloric acid is needed to completely react with 25.0 g of sodium carbonate?

$$2HCl(aq) + Na_2CO_3(s) \longrightarrow H_2O(l) + CO_2(g) + 2NaCl(aq)$$

(2)- Convert moles of sodium carbonate to moles hydrochloric acid using chemical equation

$$2\ mol\ HCl = 1\ mol\ Na_2CO_3$$

$$0.2359\ mol\ Na_2CO_3 \times \frac{2\ mol\ HCl}{1\ mol\ Na_2CO_3} = 0.4717\ mol\ HCl$$

(2)

(3)- Convert moles of hydrochloric acid to volume using concentration (M = moles/L)

$$6.00\ mol\ HCl = 1\ L$$

$$0.4717\ mol\ HCl \times \frac{1\ L}{6.00\ mol\ HCl} = 0.0786\ L\ HCl\ solution$$

(3)

$$mL = 10^{-3} L$$

Convert L to mL, since the problem statement asks us to find the mL of acid solution required.

$$0.0786\ L \times \frac{mL}{10^{-3} L} = \boxed{78.6\ mL\ of\ 6.00\ \underline{M}\ HCl}$$

EXAMPLE PROBLEM:

$$2\,Na(s) + Cl_2(g) \rightarrow 2\,NaCl(s)$$

How many grams of sodium metal is required to completely react with 2545 grams of chlorine gas?

① Convert 2545 g Cl_2 to mol Cl_2 ; FW_{Cl_2} = 70.90 g/mol

② Convert mol Cl_2 to mol Na ; equation 2 mol Na = 1 mol Cl_2

③ Convert mol Na to g Na ; FW_{Na} = 22.99 g/mol

70.90 g Cl_2 = 1 mol Cl_2 | 2 mol Na = 1 mol Cl_2 | 22.99 g Na = 1 mol Na

$$2545\text{ g } Cl_2 \times \underset{①}{\frac{1\text{ mol } Cl_2}{70.90\text{ g } Cl_2}} \times \underset{②}{\frac{2\text{ mol Na}}{1\text{ mol } Cl_2}} \times \underset{③}{\frac{22.99\text{ g Na}}{1\text{ mol Na}}} = \boxed{1650.\text{ g Na}}$$

EXAMPLE PROBLEM:

$$H_2SO_4(aq) + 2\,NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

How many mL of 0.250 M sodium hydroxide is required to completely react with 15.0 mL of 2.00 M sulfuric acid?

① Convert 15.0 mL of 2.00 M H_2SO_4 to mol H_2SO_4

② Convert mol H_2SO_4 to mol NaOH ; 1 mol H_2SO_4 = 2 mol NaOH

③ Convert mol NaOH to mL 0.250 M NaOH

* Convert mL to L, since molarity (M) is based on LITERS!

$mL = 10^{-3}\,L$

$$15.0\,mL \times \frac{10^{-3}\,L}{mL} = 0.0150\,L$$ ... is the initial volume of 2.00 M sulfuric acid

2.00 mol H_2SO_4 = 1 L ① | 1 mol H_2SO_4 = 2 mol NaOH ② | 0.250 mol NaOH = 1 L ③

$$0.0150\,L \times \frac{2.00\,mol\,H_2SO_4}{1\,L} \times \frac{2\,mol\,NaOH}{1\,mol\,H_2SO_4} \times \frac{1\,L}{0.250\,mol\,NaOH} = 0.240\,L\ NaOH$$

... since the problem asks for mL, convert 0.240 L to mL

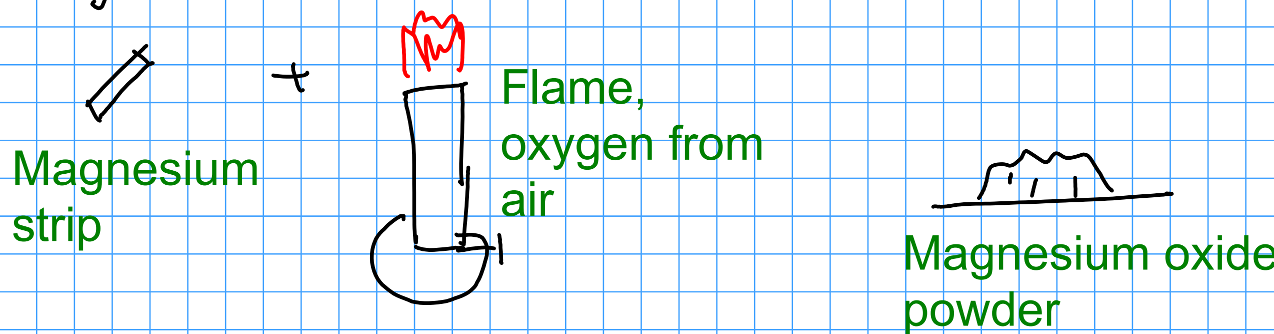
$mL = 10^{-3}\,L$

$$0.240\,L \times \frac{mL}{10^{-3}\,L} = \boxed{240.\,mL\ of\ 0.250\,M\ NaOH}$$

CONCEPT OF LIMITING REACTANT

- When does a chemical reaction STOP?

$$2\,Mg(s) + O_2(g) \xrightarrow{\Delta} 2\,MgO(s)$$



- When does this reaction stop? When burned in open air, this reaction stops when all the MAGNESIUM STRIP is gone. We say that the magnesium is LIMITING.

- This reaction is controlled by the amount of available magnesium

- At the end of a chemical reaction, the LIMITING REACTANT will be completely consumed, but there may be some amount of OTHER reactants remaining. We do chemical calculations in part to minimize these "leftovers".

- Reactants that are left at the end of a chemical reaction (in other words, they are NOT the limiting reactant) are often called "excess". So reacting magnesium with "excess oxygen" means that magnesium is limiting.