$$2\,Al(s) + 3\,Br_2(l) \longrightarrow 2\,AlBr_3(s)$$

* Given that we have 25.0 g of liquid bromine, how many grams of aluminum would we need to react away all of the bromine? How many grams of aluminum bromide would be produced?

(1) Convert grams of bromine to moles: Need formula weight $Br_2 : 2 \times 79.90 = 159.80$

$$159.80\ g\ Br_2 = 1\ mol\ Br_2$$

$$25.0\ g\ Br_2 \times \frac{1\ mol\ Br_2}{159.80\ g\ Br_2} = 0.15645\ mol\ Br_2$$

(2) Use the chemical equation to relate moles of bromine to moles of aluminum

$$2\ mol\ Al = 3\ mol\ Br_2$$

$$0.15645\ mol\ Br_2 \times \frac{2\ mol\ Al}{3\ mol\ Br_2} = 0.10430\ mol\ Al$$

(3) Convert moles aluminum to mass: Need formula weight $Al : 26.98$

$$26.98\ g\ Al = 1\ mol\ Al$$

$$0.10430\ mol\ Al \times \frac{26.98\ g\ Al}{1\ mol\ Al} = \boxed{2.81\ g\ Al}$$

You can combine all three steps on one line if you like!

$$25.0\ g\ Br_2 \times \frac{1\ mol\ Br_2}{159.80\ g\ Br_2} \times \frac{2\ mol\ Al}{3\ mol\ Br_2} \times \frac{26.98\ g\ Al}{1\ mol\ Al} = \boxed{2.81\ g\ Al}$$

① ② ③

$$\begin{array}{r} 25.0\ g\ Br_2 \\ +\ 2.81\ g\ Al \\ \hline 27.8\ g\ AlBr_3 \end{array}$$

But ...
...what would you have done to calculate the mass of aluminum bromide IF you had NOT been asked to calculate the mass of aluminum FIRST?

$$25.0\ g\ Br_2 \times \frac{1\ mol\ Br_2}{159.8\ g\ Br_2} \times \frac{2\ mol\ AlBr_3}{3\ mol\ Br_2} \times \frac{266.68\ g\ AlBr_3}{1\ mol\ AlBr_3} = 27.8\ g\ AlBr_3$$

$AlBr_3$: $Al: 1 \times 26.98$

$Br: 3 \times 79.90$

$= 266.68$

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

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

- Convert mass of sodium carbonate to moles using formula weight
- Convert moles of sodium carbonate to moles hydrochloric acid using chemical equation
- Convert moles of hydrochloric acid to volume using concentration (M = moles/L)

- Convert mass of sodium carbonate to moles using formula weight

Na_2CO_3: Na : 2 x 22.99
C : 1 x 12,01
O : 3 x 16,00
105.99

$105.99\ g\ Na_2CO_3 = 1\ mol\ Na_2CO_3$

$$25.0\ g\ Na_2CO_3 \times \frac{1\ mol\ Na_2CO_3}{105.99\ g\ Na_2CO_3} = 0.23587\ mol\ Na_2CO_3$$

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

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

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

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

$$0.235871\ mol\ Na_2CO_3 \times \frac{2\ mol\ HCl}{1\ mol\ Na_2CO_3} = 0.471743\ mol\ HCl$$

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

$$6.00\ M\ HCl: \quad 6.00\ mol\ HCl = 1\ L$$

$$0.471743\ mol\ HCl \times \frac{1\ L}{6.00\ mol\ HCl} = 0.0786\ L\ of\ solution$$

$$mL = 10^{-3}\ L$$ Convert liters to milliliters!

$$0.0786\ L\ of\ solution \times \frac{mL}{10^{-3}\ L} = \boxed{78.6\ mL\ solution}$$

EXAMPLE PROBLEM:

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

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

① Convert 2545 g Cl_2 to moles, need FW $2 \times 35.45 = 70.90$

② Convert mol Cl_2 to moles Na, need equation: 2 mol Na = 1 mol Cl_2

③ Convert mol Na to mass, need FW: 22.99 g/mol

70.90 g Cl_2 = 1 mol Cl_2 ① | 2 mol Na = 1 mol Cl_2 ② | 22.99 g Na = 1 mol Na ③

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

① ② ③

EXAMPLE PROBLEM:

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

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 moles $\quad 2.00\ mol\ H_2SO_4 = 1\ L$

② convert mol H_2SO_4 to mol NaOH: $1\ mol\ H_2SO_4 = 2\ mol\ NaOH$

③ convert mol NaOH to volume 0.250 M NaOH

$0.250\ mol\ NaOH = 1\ L$

Convert to liters, since molarity (M) is based on liters!

$1\ mL = 10^{-3}\ L$

$$15.0\ mL \times \frac{10^{-3}\ L}{mL} = 0.0150\ L\ H_2SO_4$$

This is the initial amount of sulfuric acid expressed in liters.

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

$$0.0150\ L\ H_2SO_4 \times \frac{2.00\ mol\ H_2SO_4}{1\ L}\ (①) \times \frac{2\ mol\ NaOH}{1\ mol\ H_2SO_4}\ (②) \times \frac{1\ L}{0.250\ mol\ NaOH}\ (③) = 0.240\ L$$

Answer asks for mL, so convert liters to mL.

$1\ mL = 10^{-3}\ L$ |

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