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

* 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: $\frac{2 \times 79.90}{159.80}$

$159.80\text{ g } Br_2 = 1\text{ mol } Br_2$

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

2. Use the chemical equation to relate moles of bromine to moles of aluminum

$2\text{ mol Al} = 3\text{ mol } Br_2$

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

3. Convert moles aluminum to mass: Need formula weight Al: 26.98

$26.98\text{ g Al} = 1\text{ mol Al}$

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

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

You can solve the second part of the question using CONSERVATION OF MASS - since there's only a single product and you already know the mass of all reactants.

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

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?

$$25.0\,g\,Br_2 \times \frac{1\,mol\,Br_2}{159.80\,g\,Br_2} \times \frac{2\,mol\,AlBr_3}{3\,mol\,Br_2} \times \frac{266.694\,g\,AlBr_3}{1\,mol\,AlBr_3} = 27.8\,g\,AlBr_3$$

1 convert mass bromine to moles

2 convert moles bromine to moles aluminum bromide

3 convert moles aluminum bromide to mass

Example:

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

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

1 - Convert 25.0 g sodium carbonate to moles. Use FORMULA WEIGHT.
2 - Convert moles sodium carbonate to moles HCl. Use CHEMICAL EQUATION.
3 - Convert moles HCl to volume HCl solution. Use MOLAR CONCENTRATION.

① Na_2CO_3

Na : 2 x 22.99
C : 1 x 12.01
O : 3 x 16.00

105.99 g Na_2CO_3 = mol Na_2CO_3

$$25.0\,g\,Na_2CO_3 \times \frac{mol\,Na_2CO_3}{105.99\,g\,Na_2CO_3} = 0.2358713086\,mol\,Na_2CO_3$$

② 2 mol HCl = mol Na_2CO_3

$$0.2358713086\,mol\,Na_2CO_3 \times \frac{2\,mol\,HCl}{mol\,Na_2CO_3} = 0.4717426172\,mol\,HCl$$

Example:

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

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

1 - Convert 25.0 g sodium carbonate to moles. Use FORMULA WEIGHT.
2 - Convert moles sodium carbonate to moles HCl. Use CHEMICAL EQUATION.
3 - Convert moles HCl to volume HCl solution. Use MOLAR CONCENTRATION.

3 $6.00 \text{ mol HCl} = \text{L}$

$$0.4717426172 \text{ mol HCl} \times \frac{\text{L}}{6.00 \text{ mol HCl}} = 0.0786 \text{ L of } 6.00 \text{ M HCl}$$

The problem statement asks us for a volume in MILLILITERS, so we should do a unit conversion.

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

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

25.0 mL of acetic acid solution requires 37.3 mL of 0.150 M sodium hydroxide for complete reaction. The equation for this reaction is:

$$NaOH + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + H_2O$$

What is the molar concentration of the acetic acid?

$$\frac{mol\ HC_2H_3O_2}{L\ solution} \leftarrow = 25.0\ mL\ or\ 0.0250\ L$$

Since we already know the volume of the acid, we'll just have to calculate the moles of acid to solve the problem. How? Convert the amount of NaOH to moles using its concentration, then relate the moles NaOH to the moles acid using the chemical .reaction...

$0.150\ mol\ NaOH = L$ | $mL = 10^{-3}\ L$ | $mol\ NaOH = mol\ HC_2H_3O_2$

$$37.3\ mL \times \frac{10^{-3}\ L}{mL} \times \frac{0.150\ mol\ NaOH}{L} \times \frac{mol\ HC_2H_3O_2}{mol\ NaOH} = 0.005595\ mol\ HC_2H_3O_2$$

$$M = \frac{mol\ HC_2H_3O_2}{L\ solution} = \frac{0.005595\ mol\ HC_2H_3O_2}{0.0250\ L} = \boxed{0.224\ \underline{M}\ HC_2H_3O_2}$$

Note: This procedure can be used for the calculations in the titration lab!

$$\overset{42.081\ g/mol}{4\,C_3H_6} + 6\,NO \longrightarrow \overset{53.064\ g/mol}{4\,C_3H_3N} + 6\,H_2O + N_2$$

propylene acrylonitrile

Calculate how many grams of acrylonitrile could be obtained from 651 kg of propylene, assuming there is excess NO present.

1 - Convert 651kg propylene to moles. Use FORMULA WEIGHT and kg -> g conversion.
2 - Convert moles propylene to moles acrylonitrile. Use CHEMICAL EQUATION
3 - Convert moles acrylonitrile to mass. Use FORMULA WEIGHT of acrylonitrile

$42.081\ g\ C_3H_6 = mol\ C_3H_6$	$4\ mol\ C_3H_6 = 4\ mol\ C_3H_3N$
$53.064\ g\ C_3H_3N = mol\ C_3H_3N$	$kg = 10^3\ g$

$$651\ \cancel{kg}\ \cancel{C_3H_6} \times \underbrace{\frac{10^3\ \cancel{g}}{\cancel{kg}} \times \frac{mol\ \cancel{C_3H_6}}{42.081\ \cancel{g}\ \cancel{C_3H_6}}}_{1} \times \underbrace{\frac{4\ mol\ \cancel{C_3H_3N}}{4\ \cancel{mol\ C_3H_6}}}_{2} \times \underbrace{\frac{53.064\ g\ C_3H_3N}{\cancel{mol\ C_3H_3N}}}_{3}$$

$$= \boxed{821000\ g\ C_3H_3N}$$

151.90 g/mol

$$10\,FeSO_4 + 2\,KMnO_4 + 8\,H_2SO_4 \rightarrow 5\,Fe_2(SO_4)_3 + 2\,MnSO_4 + K_2SO_4 + 8\,H_2O$$

How many mL of 0.250M potassium permangenate are needed to react with 3.36 g of iron(II) sulfate?

1 - Convert 3.36 g iron(II) sulfate to moles. Use FORMULA WEIGHT.
2 - Convert moles iron(II) sulfate to moles potassium permangenate. Use CHEMICAL EQUATION
3 - Convert moles potassium permangenate to volume. Use MOLAR CONCENTRATION.

$151.90\,g\ FeSO_4 = mol\ FeSO_4$	$10\,mol\ FeSO_4 = 2\,mol\ KMnO_4$
$0.250\,mol\ KMnO_4 = L$	$mL = 10^{-3}\,L$

$$3.36\,g\ FeSO_4 \times \frac{mol\ FeSO_4}{151.90\,g\ FeSO_4} \times \frac{2\,mol\ KMnO_4}{10\,mol\ FeSO_4} \times \frac{L}{0.250\,mol\ KMnO_4} \times \frac{mL}{10^{-3}\,L}$$

1 2 3

$$= \boxed{17.7\,mL\ of\ 0.250\,M\ KMnO_4}$$