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 grams sodium carbonate to moles. Use formula weight.
2 - Convert moles sodium carbonate to moles HCl. Use balanced chemical equation.
3 - Convert moles HCl to volume using the concentration (6.00 M).

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(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

$$25.0\,g\,Na_2CO_3 \times \frac{mol\,Na_2CO_3}{105.99\,g\,Na_2CO_3} = 0.235871\,mol\,Na_2CO_3$$

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(2) 2 mol HCl = mol Na_2CO_3

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

Example:

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3 - Convert moles HCl to volume using the concentration (6.00 M).

(3) 6.00 M: 6.00 mol HCl = L   mL = 10^{-3} L

$0.471743 \text{ mol HCl} \times \frac{L}{6.00 \text{ mol HCl}} \times \frac{mL}{10^{-3} L} = $ **78.6 mL of 6.00 M HCl**

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 mass 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 using concentration.

$151.90\ g\ FeSO_4 = mol\ FeSO_4$	$10\ mol\ FeSO_4 = 2\ mol\ KMnO_4$	$0.250\ mol\ KMnO_4 = L$

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

$$3.36\ g\ FeSO_4 \times \underbrace{\frac{mol\ FeSO_4}{151.90\ g\ FeSO_4}}_{①} \times \underbrace{\frac{2\ mol\ KMnO_4}{10\ mol\ FeSO_4}}_{②} \times \underbrace{\frac{L}{0.250\ mol\ KMnO_4} \times \frac{mL}{10^{-3}\ L}}_{③} =$$

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

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?

$$\frac{\text{mol } HC_2H_3O_2}{\text{L solution}}$$

Since we already know the volume of acetic acid solution, we actually need to calculate the number of moles of acetic acid IN the solution!

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

First, find moles of acetic acid:

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

Then, get the volume of acetic acid in the right units:

$$25.0\text{ mL} \times \frac{10^{-3}\text{ L}}{\text{mL}} = 0.0250\text{ L}$$

To get molarity, divide moles acetic acid / L acetic acid solution

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

$$42.081\ g/mol \qquad\qquad\qquad\qquad 53.064\ g/mol$$

$$4\,C_3H_6 + 6\,NO \longrightarrow 4\,C_3H_3N + 6\,H_2O + N_2$$

propylene acrylonitrile

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

1 - Convert 651 kg propylene to moles. Use formula weight.

2 - Convert moles propylene to moles acrylonitrile using chemical equation.

3 - Convert moles propylene to mass acrylonitrile using formula weight.

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

$$651\ kg\ C_3H_6 \times \frac{10^3\ g}{Kg} \times \frac{mol\ C_3H_6}{42.081\ g\ C_3H_6} \times \frac{4\ mol\ C_3H_3N}{4\ mol\ C_3H_6} \times \frac{53.064\ g\ C_3H_3N}{mol\ C_3H_3N} =$$

(1) (2) (3)

$$= \boxed{821000\ g\ C_3H_3N} \quad (821\ kg)$$