CALCULATE CONCENTRATION

1 Dilute hydrochloric acid, $HCl(aq)$, reacts with aqueous sodium carbonate, $Na_2CO_3(aq)$.

The chemical equation for the reaction is shown.

$$2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$$

(a) A 25.0 cm^3 portion of $Na_2CO_3(aq)$ was placed in a conical flask with a few drops of a suitable indicator. It was titrated against $HCl(aq)$ of concentration 0.180 mol/dm^3.

20.0 cm^3 of $HCl(aq)$ was required to reach the end-point.

Calculate the concentration of the $Na_2CO_3(aq)$, in mol/dm^3, using the following steps.

- Calculate the number of moles of HCl used in the titration.

.... mol

- Calculate the number of moles of Na_2CO_3 contained in the 25.0 cm^3 portion of $Na_2CO_3(aq)$.

.... mol

- Calculate the concentration of the $Na_2CO_3(aq)$ in mol/dm^3.

.... mol/dm^3
[3]

(b) In another experiment, the volume of carbon dioxide, CO_2, produced was 48.0 cm^3, measured at room temperature and pressure.

How many moles of CO_2 is this?

moles of CO_2 = ... mol [1]

MARKING SCHEME:

(a)	correct final answer = 0.072(0) **M1** moles HCl = 0.0036(0) **M2** moles Na_2CO_3 = 0.0018(0) (**M1** / 2) **M3** concentration Na_2CO_3 = 0.072 (**M2** / 0.025)	**3**
(b)	0.002(00)	**1**

2 **(a)** In a titration, a student added $25.0\,cm^3$ of $0.200\,mol/dm^3$ aqueous sodium hydroxide to a conical flask. The student then added a few drops of methyl orange to the solution in the conical flask.
Dilute sulfuric acid was then added from a burette to the conical flask. The volume of dilute sulfuric acid needed to neutralise the aqueous sodium hydroxide was $20.0\,cm^3$.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(i) What was the colour of the methyl orange in the aqueous sodium hydroxide?

.... [1]

(ii) Determine the concentration of the dilute sulfuric acid in g/dm^3.

- Calculate the number of moles of aqueous sodium hydroxide added to the conical flask.

.... mol

- Calculate the number of moles of dilute sulfuric acid added from the burette.

.... mol

- Calculate the concentration of the dilute sulfuric acid in mol/dm^3.

.... mol/dm^3

- Calculate the concentration of the dilute sulfuric acid in g/dm^3.

.... g/dm^3
[4]

(b) Iron(II) sulfate decomposes when heated strongly.

$$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

15.20 g of $FeSO_4(s)$ was heated and formed 4.80 g of $Fe_2O_3(s)$.

[M_r, $FeSO_4$ = 152; M_r, Fe_2O_3 = 160]

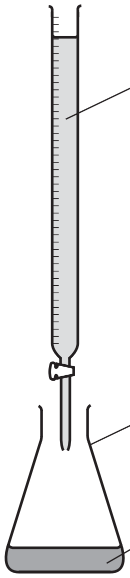
Calculate the percentage yield for this reaction.

.... % [3]

MARKING SCHEME:

(a)	(i)	yellow	**1**
	(ii)	M1 $0.2 \times 25 / 1000 = 5(.00) \times 10^{-3}$ or 0.005(00) (mol) M2 $5(.00) \times 10^{-3} / 2 = 2.5(.0) \times 10^{-3}$ or 0.0025(0) (mol) M3 $2.5(.0) \times 10^{-3} \times 1000 / 20 = 0.125$ (mol / dm^3) M4 $0.125 \times 98 = 12.25$ (g / dm^3)	**4**
(b)		M1 Mol $FeSO_4$ = 15.2 / 152 = 0.1(00) M2 Expected mol of Fe_2O_3 = 0.1 / 2 = 0.05(00)) **or** Actual mol of Fe_2O_3 = 4.80 / 160= 0.03(00) M3 Percentage yield = $100 \times 0.03(00) / 0.05(00)$ = 60%	**3**

3 **(a)** Dilute sulfuric acid and aqueous potassium hydroxide can be used to make potassium sulfate crystals using a method that includes titration.



A student titrated 25.0 cm^3 of 0.0500 mol / dm^3 aqueous potassium hydroxide with dilute sulfuric acid in the presence of an indicator. The volume of dilute sulfuric acid needed to neutralise the aqueous potassium hydroxide was 20.0 cm^3.

The equation for the reaction is shown.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

Determine the concentration of the dilute sulfuric acid.

- Calculate the number of moles of aqueous potassium hydroxide used.

.... mol

- Calculate the number of moles of dilute sulfuric acid needed to neutralise the aqueous potassium hydroxide.

.... mol

- Calculate the concentration of the dilute sulfuric acid.

.... mol / dm^3
[3]

MARKING SCHEME:

(a)	**M1** (Mol KOH =) 0.00125 / 1.25×10^{-3} **M2** (Mol H_2SO_4 =) 0.000625 / 6.25×10^{-4} **M3** (Conc H_2SO_4 =) 0.03125 / 3.125×10^{-2} (mol / dm^3)	**3**