

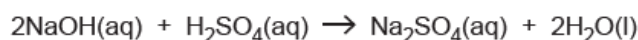
- 4 A student was given 200 cm^3 of solution **X** in which sodium hydroxide, NaOH, and sodium hydrogencarbonate, NaHCO_3 , had **both** been dissolved.

The student carried out **two different** titrations on samples of solution **X** using 0.100 mol dm^{-3} sulfuric acid, H_2SO_4 .

- In the first titration, **both** NaOH and NaHCO_3 were neutralised.
- In the second titration, **only** NaOH was neutralised.

The student's results for the titrations of 25.0 cm^3 samples of solution **X** are shown.

volume of H_2SO_4 needed to neutralise both NaOH and NaHCO_3	29.50 cm^3
volume of H_2SO_4 needed to neutralise only NaOH	18.00 cm^3



- (a) (i) Calculate the amount, in mol, of H_2SO_4 used to neutralise **only** the NaOH in 25.0 cm^3 of solution **X**.

$$V(\text{H}_2\text{SO}_4) = 18\text{ cm}^3 = 0.018\text{ dm}^3$$

$$C(\text{H}_2\text{SO}_4) = 0.100\text{ mol dm}^{-3}$$

The volume is given in the table. Remember to convert to dm^3 . The concentration is given in the question at the top.

$$n(\text{H}_2\text{SO}_4) = cV = 0.018 \times 0.100 = 1.8 \times 10^{-3}\text{ mol}$$

$$\text{Amount} = \dots\dots 1.8 \times 10^{-3}$$

- (ii) Calculate the concentration, in mol dm^{-3} , of NaOH in solution **X**.

$$n(\text{H}_2\text{SO}_4) = 1.8 \times 10^{-3}\text{ mol}$$

$$n(\text{NaOH}) = 2 \times n(\text{H}_2\text{SO}_4) = 0.144\text{ mol}$$

$$\text{Concentration} = \dots\dots\dots 0.144 \dots\dots\dots \text{ mol dm}^{-3} \text{ [1]}$$

You can find the molar ratio between NaOH and H_2SO_4 in the first reaction equation above: it is 2:1 for NaOH : H_2SO_4 . Hence you have to times the moles of H_2SO_4 that you calculated in (a) (i) by 2.

- (b) (i) Calculate the amount, in mol, of NaHCO_3 in the 200 cm^3 of solution **X**.

$$V(\text{H}_2\text{SO}_4 \text{ used for } \text{NaHCO}_3 \text{ in } 25\text{ cm}^3) = 29.50 - 18.00 = 11.5\text{ cm}^3 = 0.0115\text{ dm}^3.$$

$$C(\text{H}_2\text{SO}_4) = 0.100\text{ mol dm}^{-3}.$$

$$n(\text{H}_2\text{SO}_4 \text{ used for } \text{NaHCO}_3 \text{ in } 25\text{ cm}^3) = cV = 0.100 \times 0.0115 = 0.00115\text{ mol}$$

$$n(\text{NaHCO}_3 \text{ in } 25\text{ cm}^3) = 2 \times n(\text{H}_2\text{SO}_4 \text{ used for } \text{NaHCO}_3 \text{ in } 25\text{ cm}^3) = 0.00230\text{ mol}$$

Since you know the volumes needed to neutralise both NaOH and NaCO_3 , and we know the volume required to neutralise just NaOH, we can take the away from each

You can find the molar ratio between NaHCO_3 and H_2SO_4 in the second reaction equation above: it is 2:1 for NaHCO_3 : H_2SO_4 . Hence you have to times the moles of H_2SO_4 that you calculated in (a) (i) by 2.

$$n(\text{NaHCO}_3 \text{ in } 200\text{cm}^3) = (200/25) \times 0.00230 = 0.0184\text{mol}$$

You need to work out how many times 25 goes into 200 to calculate the number of moles in 200cm^3 .

(ii) Calculate the mass of NaHCO_3 in the 200cm^3 of solution **X**.

Give your answer to **three** significant figures.

$$n(\text{NaHCO}_3 \text{ in } 200\text{cm}^3) = 0.0184\text{mol}$$

$$M_r(\text{NaHCO}_3) = 23 + 1 + 12 + (3 \times 16) = 84\text{g mol}^{-1}.$$

$$m(\text{NaHCO}_3) = n M_r = 0.0184 \times 84 = 1.55\text{g}$$

Mass = **1.55** **↓ [1]**

[Total: 5]