OCR June 2015 F321

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

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

$$2NaHCO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$$

(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**.

$V(H_2SO_4) = 18cm^3 = 0.018dm^3$

$C(H_2SO_4) = 0.100mol\ dm^{-3}$

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

$n(H_2SO_4) = cV = 0.018 \times 0.100 = 1.8 \times 10^{-3}$ mol

Amount = 1.8×10^{-3} .....

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

$n(H_2SO_4) = 1.8 \times 10^{-3}$ mol

$n(NaOH) = 2 \times n(H_2SO_4) = 0.144$ mol

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.

Concentration = 0.144 ..... mol dm^{-3} **[1]**

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

$V(H_2SO_4$ used for $NaHCO_3$ in $25cm^3) = 29.50 - 18.00 = 11.5cm^3 = 0.0115dm^3$.

$C(H_2SO_4) = 0.100mol\ dm^{-3}$.

$n(H_2SO_4$ used for $NaHCO_3$ in $25cm^3) = cV = 0.100 \times 0.0115 = 0.00115mol$

$n(NaHCO_3$ in $25cm^3) = 2 \times n(H_2SO_4$ used for $NaHCO_3$ in $25cm^3) = 0.00230mol$

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.

$n(NaHCO_3 \text{ in } 200cm^3) = (200/25) \times 0.00230 = 0.0184 mol$

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 $200\,cm^3$ of solution **X**.

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

$n(NaHCO_3 \text{ in } 200cm^3) = 0.0184 mol$

$M_r(NaHCO_3) = 23 + 1 + 12 + (3 \times 16) = 84 g\ mol^{-1}$.

$m(NaHCO_3) = n\,M_r = 0.0184 \times 84 = 1.55g$

Mass = 1.55 g **[1]**

[Total: 5]