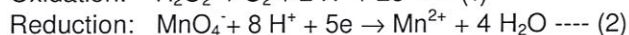
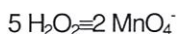
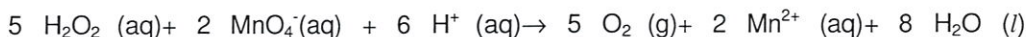


5 In an experiment, 10.0 cm<sup>3</sup> of 0.200 mol dm<sup>-3</sup> solution of acidified potassium manganate(VII) was made up to 250 cm<sup>3</sup>. 25.0 cm<sup>3</sup> of this diluted solution was then titrated with 34.50 cm<sup>3</sup> of hydrogen peroxide solution.

(a) Calculate the concentration of hydrogen peroxide solution. [2]



Overall: (1) x 5 + (2) x 2



$$\text{No. of mol of MnO}_4^- \text{ in } 250 \text{ cm}^3 = 0.200 \times \frac{10.0}{1000} = 2.00 \times 10^{-3} \quad [1/2]$$

$$\text{No. of mol of MnO}_4^- \text{ in } 25.0 \text{ cm}^3 = 2.00 \times 10^{-3} \times \frac{25.0}{250} = 2.00 \times 10^{-4} \quad [1/2]$$

$$\text{No. of mol of H}_2\text{O}_2 \text{ in } 34.50 \text{ cm}^3 = 2.00 \times 10^{-4} \times \frac{5}{2} = 5.00 \times 10^{-4} \quad [1/2]$$

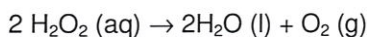
$$[\text{H}_2\text{O}_2] = n/v = \frac{5.00 \times 10^{-4}}{34.50/1000} = \underline{1.45 \times 10^{-2} \text{ mol dm}^{-3}} \quad [1/2]$$

(b) Determine the volume strength of the hydrogen peroxide solution [2]

Recall:

Use the decomposition equation not the oxidation half equation of H<sub>2</sub>O<sub>2</sub> in c(i)

Decomposition of H<sub>2</sub>O<sub>2</sub>:



$$\text{No. of mol of H}_2\text{O}_2 \text{ in } 1 \text{ dm}^3 \text{ of } 1.45 \times 10^{-2} \text{ mol dm}^{-3} \text{ H}_2\text{O}_2 = 1.45 \times 10^{-2} \quad [1/2]$$

$$\text{No. of mol of O}_2 \text{ produced by } 1 \text{ dm}^3 \text{ of H}_2\text{O}_2 = 1.45 \times 10^{-2} \times \frac{1}{2} = 0.00725 \quad [1/2]$$

Volume of O<sub>2</sub> produced by 1 dm<sup>3</sup> of a 1.45 x 10<sup>-2</sup> mol dm<sup>-3</sup> H<sub>2</sub>O<sub>2</sub> at s.t.p.

$$= 0.00725 \times 22.4$$

$$= 0.162 \text{ dm}^3 \quad [1/2]$$

$$\text{Volume strength of H}_2\text{O}_2 = \frac{\text{Volume of O}_2 \text{ produced}}{\text{Volume of H}_2\text{O}_2 \text{ solution}} = \frac{0.162}{1} = \underline{0.162 \text{ (no units)}}$$

[1/2]

[Total : 4 marks]

- 6 Pyrolusite is a mineral, which contains manganese dioxide. It is used for the large scale production of potassium manganate(VII). The process involves two steps:

**Step 1**

The pyrolusite is reacted with potassium hydroxide and heated in the presence of oxygen to form potassium manganate(VI) and water.

**Step 2**

Potassium manganate(VI) is then electrolytically oxidized to potassium manganate(VII).

To determine the percentage composition of manganese dioxide, a sample of pyrolusite that weighed 2.50 g was treated according to Step 1 and 2. The potassium manganate(VII) formed required 24.00 cm<sup>3</sup> of 4.80 mol dm<sup>-3</sup> of iron (II) sulfate solution for complete reaction.

- (a) Write the balanced equation for the formation of potassium manganate(VI) from manganese dioxide. [1]

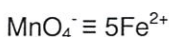


- (b) Write the balanced equation for the reaction of potassium manganate(VII) with iron (II) sulfate. [1]



- (c) Calculate the percentage composition of manganese dioxide in pyrolusite. [3]  
(Ans: 80.0%)

$$\text{No. of moles of Fe}^{2+} = 4.80 \times 0.024 = 0.115 [1/2]$$



$$\text{No of moles of MnO}_4^- = \frac{1}{5} \times 0.115 = 0.0230 [1/2]$$



$$\text{No of moles of MnO}_2 = 0.0230 [1/2]$$

$$\text{Mass of MnO}_2 = 0.0230 \times (54.9 + 2 \times 16) = 2.00 \text{ g} [1/2]$$

$$\text{Percentage composition} = \frac{2}{2.5} \times 100\% [1/2] = \underline{80.0\%} \quad [1/2]$$

- (d) Is it possible to use iron (II) chloride in place of iron (II) sulfate for the determination of potassium manganate (VII)? Justify your answer. [1]

No. Because the chloride ions will be **oxidised** by potassium manganate(VII). [1]

[Total: 6 marks]