

Chemistry - Dulani Maduranga දුලානි මදුරංග - රසායන විද්‍යාව Chemistry - Dulani Maduranga දුලානි මදුරංග - රසායන විද්‍යාව Chemistry - Dulani Maduranga දුලානි මදුරංග - රසායන විද්‍යාව Chemistry - Dulani Maduranga දුලානි මදුරංග - රසායන විද්‍යාව Chemistry - Dulani Maduranga දුලානි මදුරංග - රසායන විද්‍යාව

දුලානි මදුරංග - රසායන විද්‍යාව විභාග මධ්‍යස්ථානය

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අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ), 2023 අගෝස්තු

General Certificate Of Education (Adv. Level) Examination, August 2023

රසායන විද්‍යාව I
Chemistry I

02 S/E I

Universal gas constant $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

Plank's constant $h = 6.626 \times 10^{-34} \text{ J s}$

Avogadro constant $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

Velocity of light $c = 3 \times 10^8 \text{ m s}^{-1}$

Introduction to paper Class- 07 -2023 A/L

❖ Answer all the Questions.

1. (b) The water sample **Y** contains the anions SO_3^{2-} , SO_4^{2-} and NO_3^- . The following procedures were carried out for the quantitative analysis of the anions present in the water sample.

Procedure 1

To 25.00 cm^3 of sample **Y**, an excess of a dilute solution of BaCl_2 was added with stirring. Thereafter, excess dilute HCl was added with stirring to the precipitate formed until there was no further evolution of a gas with pungent odour. The solution was allowed to stand for 10 minutes and filtered. The precipitate was washed with distilled water and dried in an oven at 105°C until a constant mass was obtained. The mass of the precipitate was 0.174 g . The filtrate obtained was kept for further analysis (see **procedure 3**).

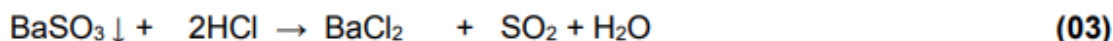
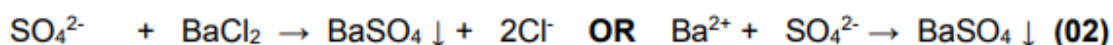
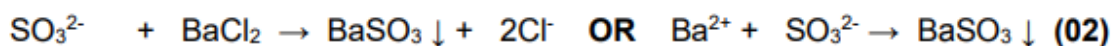
Procedure 2

To 25.00 cm^3 of sample **Y**, an excess of dilute H_2SO_4 and acidified $5\% \text{ KIO}_3$ solutions were added. The liberated I_2 was immediately titrated with $0.020 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ solution using starch as the indicator. The volume of $\text{Na}_2\text{S}_2\text{O}_3$ used was 20.00 cm^3 . (Assume that in this procedure, SO_3^{2-} ions are oxidized to sulphate ions (SO_4^{2-}) without any loss to the atmosphere.)

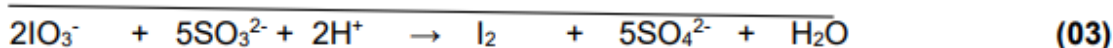
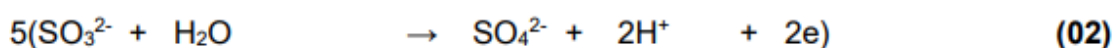
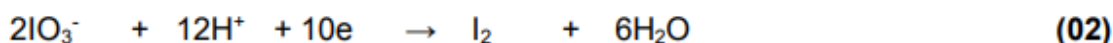
Procedure 3

The filtrate from **procedure 1** was neutralized with dilute NaOH and to it excess Al powder and dilute NaOH were added. The solution was heated and the gas evolved was transferred quantitatively to react with a 20.00 cm^3 volume of $0.11 \text{ mol dm}^{-3} \text{ HCl}$ solution. Completion of the reaction was tested with litmus. The HCl remaining after reacting with the gas evolved was titrated with $0.10 \text{ mol dm}^{-3} \text{ NaOH}$ solution using methyl orange as the indicator. The volume of NaOH required was 10.00 cm^3 .

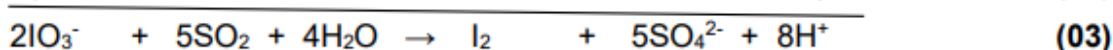
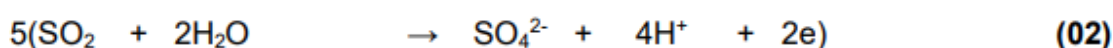
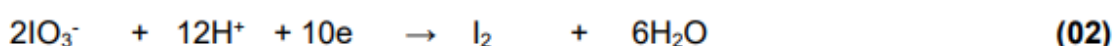
- Write balanced ionic/non-ionic equations for the reactions taking place in **procedures 1, 2 and 3**.
- Determine the concentrations (mol dm^{-3}) of SO_3^{2-} , SO_4^{2-} and NO_3^- in water sample **Y**.
(Ba = 137; S = 32; O = 16)

Procedure 1

BaSO_4 will remain insoluble

Procedure 2

OR

Procedure 3

Procedure 2 – Determination of SO_3^{2-}

$$\text{Moles of } \text{S}_2\text{O}_3^{2-} = \frac{0.02}{1000} \times 20 \quad (02)$$

$$\text{Therefore, moles of } \text{SO}_3^{2-} = \frac{0.02}{1000} \times 20 \times \frac{5}{2} \quad (02)$$

$$\begin{aligned} \text{Concentration of } \text{SO}_3^{2-} &= \frac{0.02}{1000} \times 20 \times \frac{5}{2} \times \frac{1000}{25} \quad (02) \\ &= \mathbf{0.04 \text{ mol dm}^{-3}} \quad (03 + 01) \end{aligned}$$

Procedure 3 – Determination of NO_3^-

$$\text{Moles of HCl} = \frac{0.11}{1000} \times 20 \quad (02)$$

$$\text{Moles of NaOH} = \frac{0.10}{1000} \times 10 \quad (02)$$

Since NaOH and HCl react in the ratio of 1:1

$$\text{Moles of HCl reacted with } \text{NH}_3 = \frac{0.11}{1000} \times 20 - \frac{0.10}{1000} \times 10 \quad (02)$$

$$= \frac{1}{1000} (2.2 - 1) = \frac{1.2}{1000} \quad (02)$$

$$\text{Therefore, moles of } \text{NH}_3 = \frac{1.2}{1000} \quad (02)$$

$$\text{Therefore, moles of } \text{NO}_3^- = \frac{1.2}{1000} \quad (02)$$

$$\begin{aligned} \text{Concentration of } \text{NO}_3^- &= \frac{1.2}{1000} \times \frac{1000}{25} \quad (02) \\ &= \mathbf{0.048 \text{ mol dm}^{-3}} \quad (03 + 01) \end{aligned}$$

Procedure 4 – Determination of SO_4^{2-}

$$\text{Molar mass of } \text{BaSO}_4 = 137 + 32 + 64 = 233 \quad (02)$$

$$\text{Mass of } \text{BaSO}_4 \text{ precipitate} = 0.174 \text{ g}$$

$$\text{Therefore, moles of } \text{BaSO}_4 = \frac{0.174}{233} \quad (02)$$

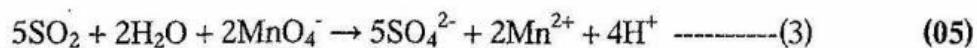
$$\text{Therefore, moles of } \text{SO}_4^{2-} = \frac{0.174}{233} = 7.47 \times 10^{-4} \quad (02)$$

$$\begin{aligned} \text{Concentration of } \text{SO}_4^{2-} &= \frac{7.47 \times 10^{-4}}{25} \times 1000 \quad (02) \\ &= \mathbf{0.029 (0.03) \text{ mol dm}^{-3}} \quad (03 + 01) \end{aligned}$$

2.

Dulan Madurange

$$\begin{aligned}\text{Moles of MnO}_4^- \text{ reacted with CuS} &= (8.4 \times 10^{-3}) - (2.1 \times 10^{-4}) \\ &= 8.2 \times 10^{-3} \quad (02)\end{aligned}$$



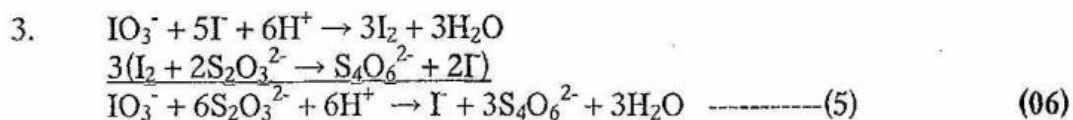
$$\begin{aligned}\text{From relationship (4), moles of CuS} &= 5/8 \times 8.2 \times 10^{-3} \quad (03) \\ &= 5.1 \times 10^{-3} \quad (01)\end{aligned}$$

$$\text{Therefore, moles of Cu}^{2+} \text{ in } 25.00 \text{ cm}^3 = 5.1 \times 10^{-3} \quad (01)$$

$$[\text{Cu}^{2+}] = 5.1 \times 10^{-3} / 25 \times 1000 \text{ mol dm}^{-3} \quad (01)$$

$$[\text{Cu}^{2+}] = 0.20 \text{ mol dm}^{-3} \quad (03 + 02)$$

(40 marks)



For first two reactions only, award (02) + (02) marks

$$\text{Moles of S}_2\text{O}_3^{2-} = 0.4/1000 \times 25 \quad (03)$$

$$\text{From eq.(5), moles of H}^+ \text{ in } 25.00 \text{ cm}^3 = 0.4/1000 \times 25 \quad (03)$$

$$[\text{H}^+] = 0.4/1000 \times 25 \times 1000/25 \text{ mol dm}^{-3} \quad (03)$$

$$[\text{H}^+] = 0.4 \text{ mol dm}^{-3} \quad (03 + 02)$$

(20 marks)

Total 8(b) = 75 marks

3. 2012 AL

(b) (i) A 3d block element M forms an ion M^{n+} . This ion can be oxidized by MnO_4^- in a dil. H_2SO_4 medium to give the MO_2^+ ion. In an experiment, 30.0 cm^3 of 0.100 mol dm^{-3} $KMnO_4$ was required to oxidize $5.00 \times 10^{-3}\text{ mol}$ of M^{n+} to MO_2^+ . Use this data to calculate the value of n .

(ii) The following procedures I and II were used to determine the percentage of Cu in the Cu-containing alloy Z.

Procedures:

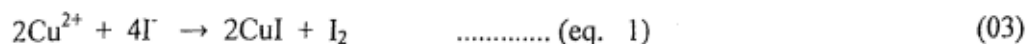
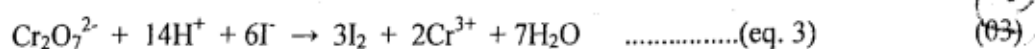
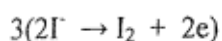
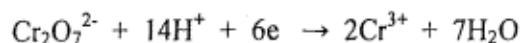
I. A sample of 2.80 g of the alloy Z was dissolved in 500.0 cm^3 of dil. H_2SO_4 . Addition of excess KI to 25.0 cm^3 of this solution produced the white precipitate CuI , and I_2 as the only products. The liberated I_2 was titrated with $Na_2S_2O_3$ solution using starch as the indicator. The volume of $Na_2S_2O_3$ solution required was 30.0 cm^3 .

II. To 25.0 cm^3 of $K_2Cr_2O_7$ solution, prepared by dissolving 1.18 g in 500.0 cm^3 of distilled water, 20 cm^3 of dil. H_2SO_4 and excess KI were added. The liberated I_2 was titrated with the $Na_2S_2O_3$ solution used in procedure I with starch as the indicator. The volume of $Na_2S_2O_3$ required was 24.0 cm^3 .

1. Give balanced chemical equations for the reactions taking place in procedures I and II.
2. Determine the percentage of Cu in alloy Z.
3. Indicate the colour changes you would observe at the end points of the titrations in procedures I and II.

(O = 16, K = 39, Cr = 52, Cu = 63.5)

(8.0 marks)

(ii) 1. Procedure IProcedure II2. METHOD 1Considering Procedure II

Combining (eq. 3) + (3 x eq. 4)



$$\text{Molar mass of K}_2\text{Cr}_2\text{O}_7 = 294 \text{ g mol}^{-1} \quad (02)$$

$$\begin{aligned} \text{Concentration of K}_2\text{Cr}_2\text{O}_7 \text{ solution} &= \frac{1.18}{294} \times \frac{1000}{500} \\ &= 0.008 \text{ mol dm}^{-3} \end{aligned} \quad (03)$$

$$\text{Moles of K}_2\text{Cr}_2\text{O}_7 \text{ in } 25.0 \text{ cm}^3 = \frac{0.008}{1000} \times 25 \quad (03)$$

$$\text{Therefore, Moles of S}_2\text{O}_3^{2-} = \frac{0.008}{1000} \times 25 \times 6 \quad (03)$$

$$[\text{S}_2\text{O}_3^{2-}] = \frac{0.008}{1000} \times 25 \times 6 \times \frac{1000}{24}$$

$$\text{Concentration of Na}_2\text{S}_2\text{O}_3 \text{ solution} = 0.05 \text{ mol dm}^{-3} \quad (03)$$

Considering Procedure I

$$\text{No. of moles of } \text{S}_2\text{O}_3^{2-} = \frac{0.05}{1000} \times 30 \quad (03)$$

Combining (eq. 1) + (eq. 2)



$$\text{Hence, } \text{Cu}^{2+} \equiv \text{S}_2\text{O}_3^{2-} \quad (03)$$

$$\text{Therefore, Moles of } \text{Cu}^{2+} \text{ present in } 25.0 \text{ cm}^3 = \frac{0.05}{1000} \times 30 \quad (03)$$

$$\text{Moles of } \text{Cu}^{2+} \text{ in } 500.0 \text{ cm}^3 = \frac{0.05}{1000} \times 30 \times \frac{500}{25} \quad (03)$$

$$\begin{aligned} \text{Therefore, weight of } \text{Cu}^{2+} &= \frac{0.05}{1000} \times 30 \times \frac{500}{25} \times 63.5 \\ &= 1.9 \text{ g} \end{aligned} \quad (03)$$

$$\begin{aligned} \% \text{ Cu in alloy Z} &= \frac{1.9}{2.80} \times 100 \\ &= 68\% \end{aligned} \quad (05)$$