

SOLUTIONS

Module - 2 / JEE-2022

IN-CHAPTER EXERCISES	Chemistry	Stoichiometry - II (Redox Reactions)
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EXERCISE-A

- (i) $\text{HClO}_4 : (+1) \times 1 + (x) \times 1 + (-2) \times 4 = 0 \Rightarrow x = +7$

(ii) $\text{Ba}(\text{ClO}_3)_2 : (+2) \times 1 + (x) \times 2 + (-2) \times 6 = 0 \Rightarrow x = +5$

(iii) CrO_2Cl_2 : Chromyl chloride : In chlorides, 0.5 of Cl is always -1. (iv) $\text{Cl}_2\text{O}_7 : (x) \times 2 + (-2) \times 7 = 0 \Rightarrow x = +7$
- (i) $\text{CN}^- \longrightarrow \text{N}_2 + \text{HCO}_3^-$ and $\text{OCl}^- \longrightarrow \text{Cl}^-$
(Both C and N are oxidised) (Reduced)

(ii) $\text{O}_3 \longrightarrow \text{O}_2$ and $\text{C}_6\text{H}_5\text{OH} \longrightarrow \text{CO}_2$
Reduced Oxidised

(iii) $\text{I}^- \longrightarrow \text{I}_2$ and $\text{O}_3 \longrightarrow \text{O}_2$ (iv) $\text{S}_2\text{O}_3^{2-} \longrightarrow \text{HSO}_4^-$ and $\text{Cl}_2 \longrightarrow \text{Cl}^-$
Oxidised Reduced Oxidised Reduced

(v) $\text{C} \longrightarrow \text{CO}$ and $\text{ZnO} \longrightarrow \text{Zn}$
Oxidised Reduced
- (i) $\text{Te}(\text{s}) + \text{NO}_3^-(\text{aq.}) \longrightarrow \text{TeO}_2(\text{s}) + \text{NO}(\text{g})$
Oxidation : $\text{Te}(\text{s}) + 2\text{H}_2\text{O} \longrightarrow \text{TeO}_2(\text{s}) + 4\text{H}^+ + 4\text{e}^-$; Reduction : $\text{NO}_3^-(\text{aq.}) + 4\text{H}^+ + 3\text{e}^- \longrightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}$

(ii) $\text{H}_2\text{O}_2(\text{aq.}) + \text{Fe}^{2+}(\text{aq.}) \longrightarrow \text{Fe}^{3+}(\text{aq.}) + \text{H}_2\text{O}(\ell)$
Oxidation : $\text{Fe}^{2+}(\text{aq.}) \longrightarrow \text{Fe}^{3+}(\text{aq.}) + \text{e}^-$; Reduction : $\text{H}_2\text{O}_2(\text{aq.}) + 2\text{H}^+ + 2\text{e}^- \longrightarrow 2\text{H}_2\text{O}(\ell)$

(iii) $\text{Mn}(\text{s}) + \text{NO}_3^-(\text{aq.}) \longrightarrow \text{Mn}^{2+}(\text{aq.}) + \text{NO}_2(\text{g})$
Oxidation : $\text{Mn}(\text{s}) \longrightarrow \text{Mn}^{2+}(\text{aq.}) + 2\text{e}^-$; Reduction : $\text{NO}_3^-(\text{aq.}) + 2\text{H}^+ + \text{e}^- \longrightarrow \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\ell)$

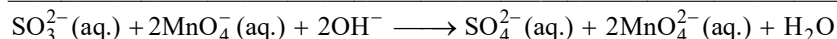
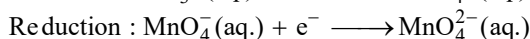
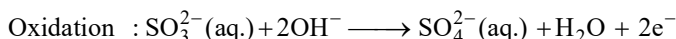
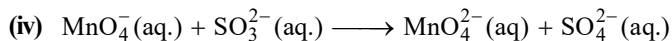
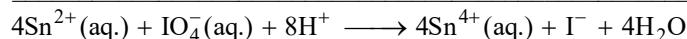
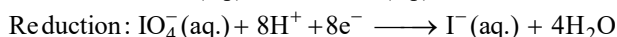
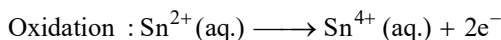
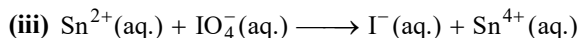
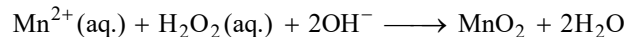
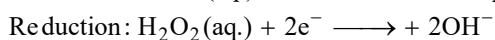
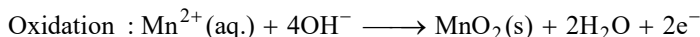
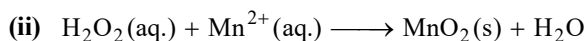
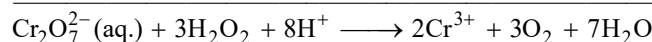
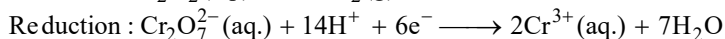
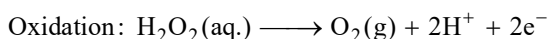
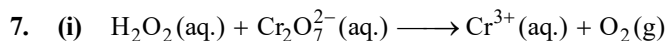
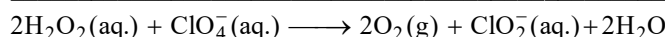
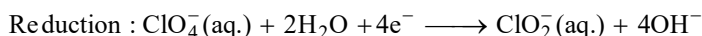
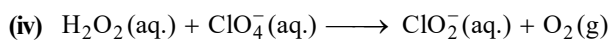
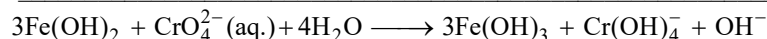
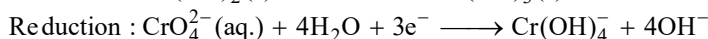
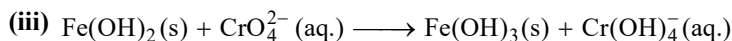
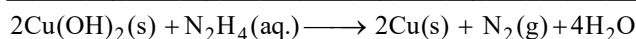
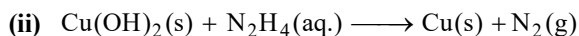
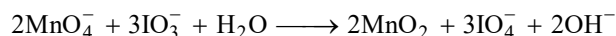
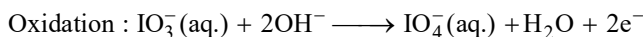
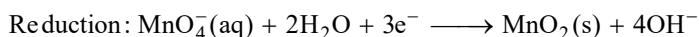
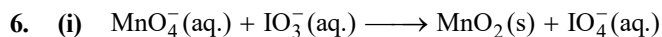
(iv) $\text{Mn}^{3+}(\text{aq.}) \longrightarrow \text{MnO}_2(\text{s}) + \text{Mn}^{2+}(\text{aq.})$ (Disproportionation R_x^n)
Oxidation : $\text{Mn}^{3+}(\text{aq.}) + 2\text{H}_2\text{O} \longrightarrow \text{MnO}_2(\text{s}) + 4\text{H}^+ + \text{e}^-$; Reduction : $\text{Mn}^{3+}(\text{aq.}) + \text{e}^- \longrightarrow \text{Mn}^{2+}(\text{aq.})$
- (i) $\text{VO}^{2+}(\text{aq.}) \longrightarrow \text{V}^{3+}(\text{aq.}) \Rightarrow \text{VO}^{2+}(\text{aq.}) + 2\text{H}^+ + \text{e}^- \longrightarrow \text{V}^{3+}(\text{aq.}) + \text{H}_2\text{O}$

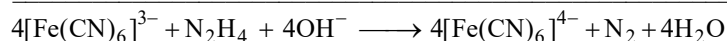
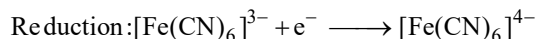
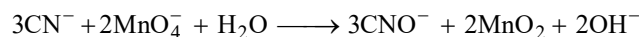
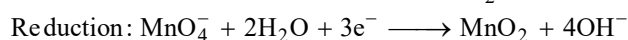
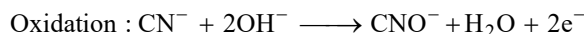
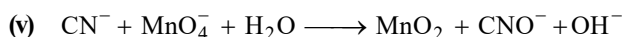
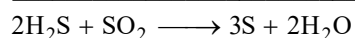
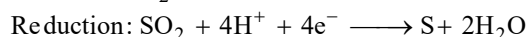
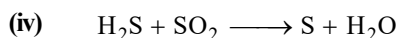
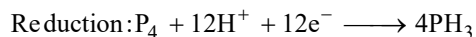
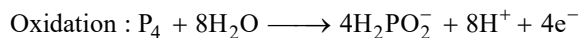
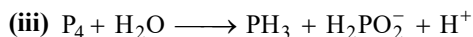
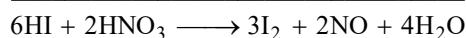
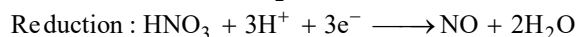
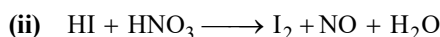
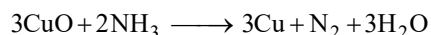
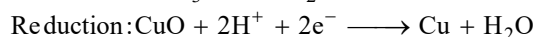
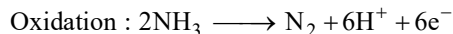
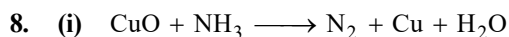
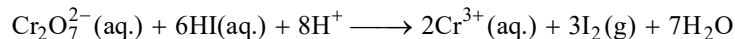
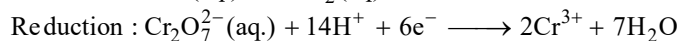
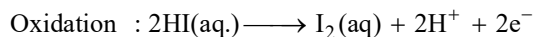
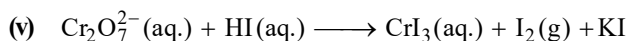
(ii) $\text{NO}_3^-(\text{aq.}) \longrightarrow \text{NO}_2(\text{g}) \Rightarrow \text{NO}_3^-(\text{aq.}) + 2\text{H}^+ + \text{e}^- \longrightarrow \text{NO}_2 + \text{H}_2\text{O}$

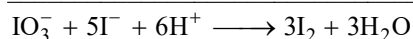
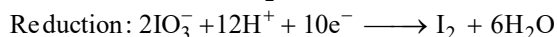
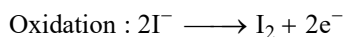
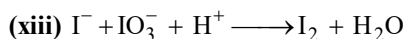
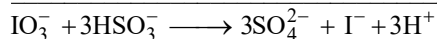
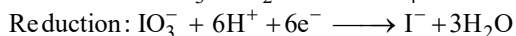
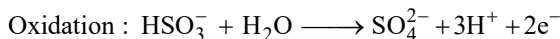
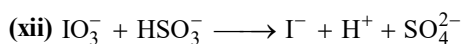
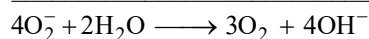
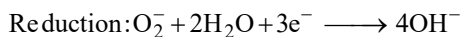
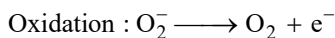
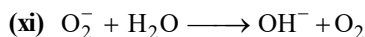
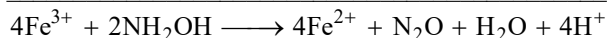
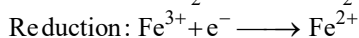
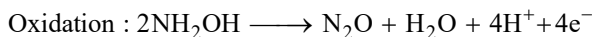
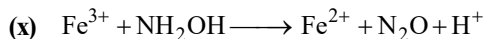
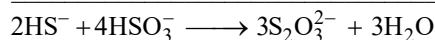
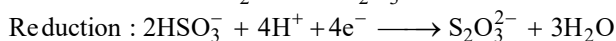
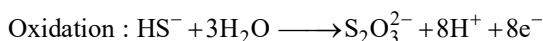
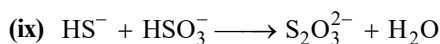
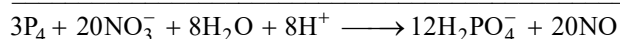
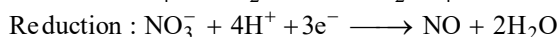
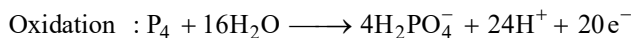
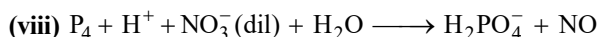
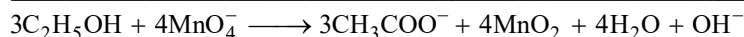
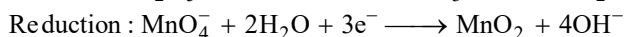
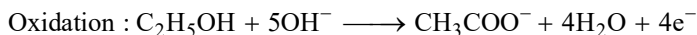
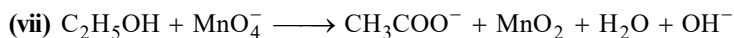
(iii) $\text{IO}_3^-(\text{aq.}) \longrightarrow \text{I}_3^-(\text{aq.}) \Rightarrow 3\text{IO}_3^- + 18\text{H}^+ + 18\text{e}^- \longrightarrow \text{I}_3^- + 9\text{H}_2\text{O}$
- (i) $\text{CrO}_4^{2-}(\text{aq.}) \longrightarrow \text{Cr}(\text{OH})_4^-(\text{aq.}) \Rightarrow \text{CrO}_4^{2-}(\text{aq.}) + 4\text{H}_2\text{O} + 3\text{e}^- \longrightarrow \text{Cr}(\text{OH})_4^- + 4\text{OH}^-$

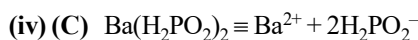
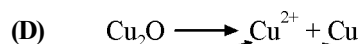
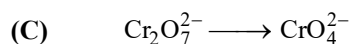
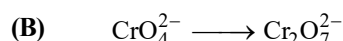
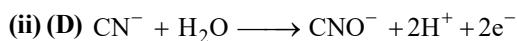
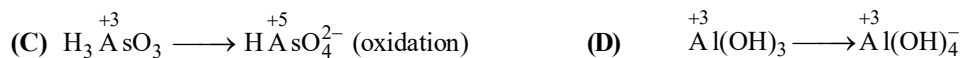
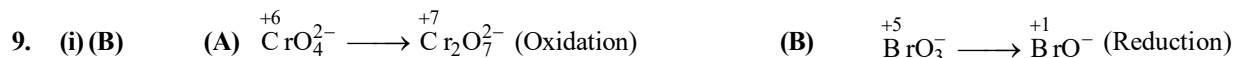
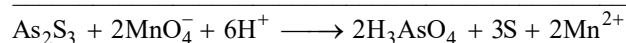
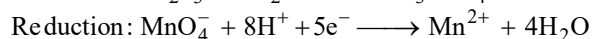
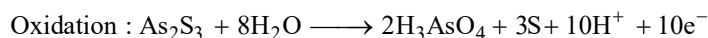
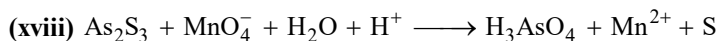
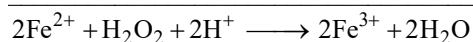
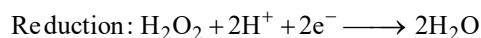
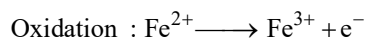
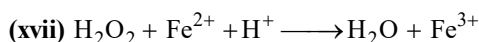
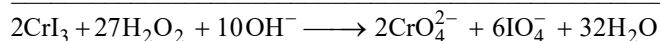
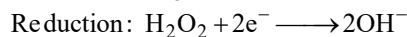
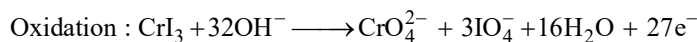
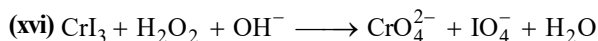
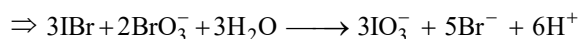
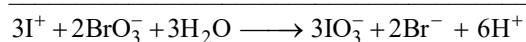
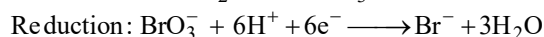
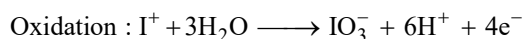
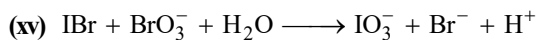
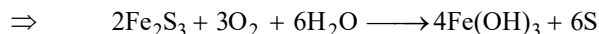
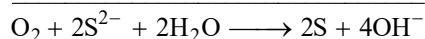
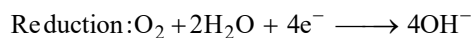
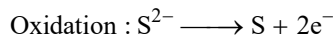
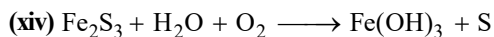
(ii) $\text{Bi}^{3+}(\text{aq.}) \longrightarrow \text{BiO}_3^-(\text{aq.}) \Rightarrow \text{Bi}^{3+}(\text{aq.}) + 6\text{OH}^- \longrightarrow \text{BiO}_3^-(\text{aq.}) + 3\text{H}_2\text{O} + 2\text{e}^-$

(iii) $\text{ClO}^-(\text{aq.}) \longrightarrow \text{Cl}^-(\text{aq.}) \Rightarrow \text{ClO}^-(\text{aq.}) + \text{H}_2\text{O} + 2\text{e}^- \longrightarrow \text{Cl}^-(\text{aq.}) + 2\text{OH}^-$

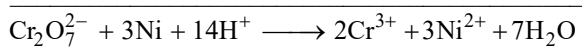
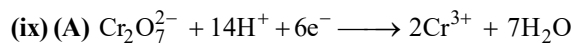
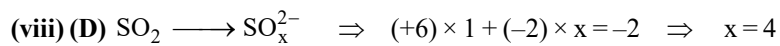
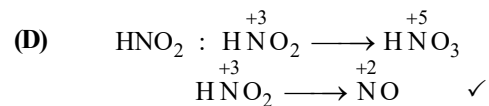
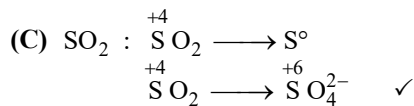
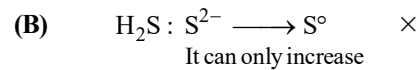
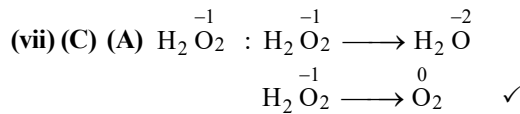
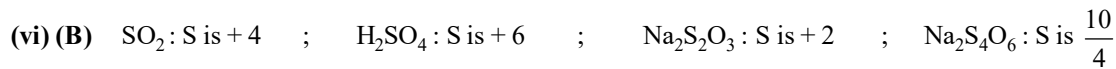
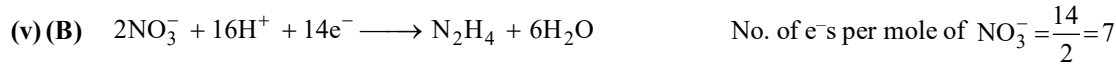








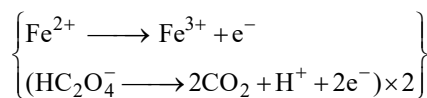
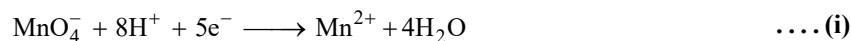
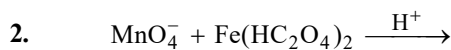
$$(+1) \times 2 + (x) \times 1 + (-2) \times 2 = -1 \Rightarrow x = +1$$



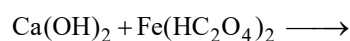
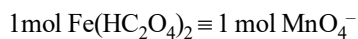
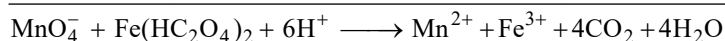
EXERCISE-B



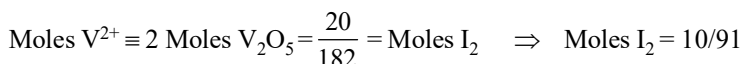
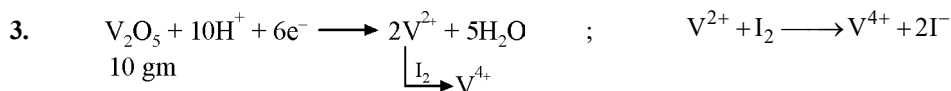
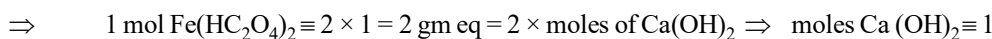
$$\frac{n_{\text{MnO}_4^-/\text{H}^+}}{n_{\text{MnO}_4^-/\text{OH}^-}} = \frac{2/5}{2/1} = 0.2$$

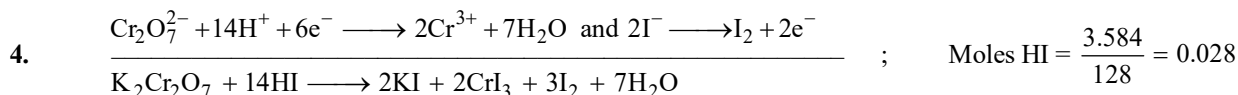


.... (ii)



Typical neutralisation HC_2O_4^- is monobasic acid as well as monoacidic base



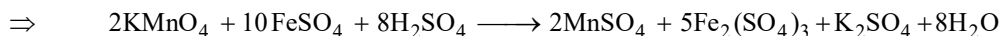
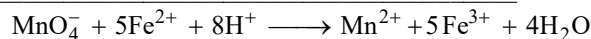
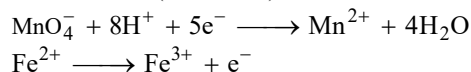
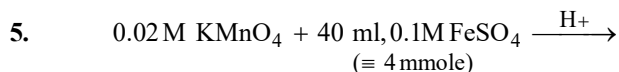


(a) Moles of $\text{K}_2\text{Cr}_2\text{O}_7 = \frac{94}{294} = 0.32 \Rightarrow$ Moles of HI required = $14 \times 0.32 <$ moles HI available.

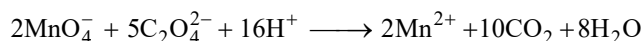
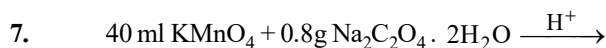
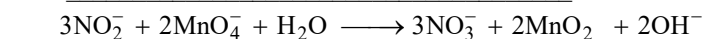
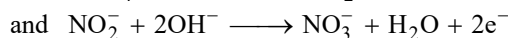
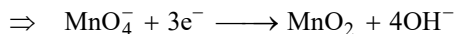
\Rightarrow HI is the limiting reagent. \Rightarrow Moles $\text{K}_2\text{Cr}_2\text{O}_7$ consumed = $\frac{1}{14} \times 0.028 = 0.002$

\Rightarrow Moles $\text{K}_2\text{Cr}_2\text{O}_7$ Left = $0.32 - 0.002 = 0.318 \Rightarrow$ % of $\text{K}_2\text{Cr}_2\text{O}_7 = \frac{0.318}{0.32} = 99.375\%$

(b) Mole of $\text{I}_2 = \frac{3}{14} \times$ moles HI = 0.006 $\Rightarrow V_{\text{I}_2} = \frac{0.0821 \times 546 \times 0.006}{1} = 268.96$ ml



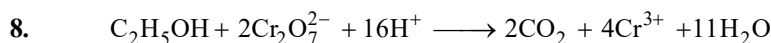
$\Rightarrow 1 \text{ mmol KMnO}_4 \equiv 5 \text{ mmol FeSO}_4 \Rightarrow 4 \text{ mmol FeSO}_4 = \frac{4}{5} \text{ mmol KMnO}_4 = 0.02 \times V_{\text{KMnO}_4} \Rightarrow V_{\text{KMnO}_4} = 40 \text{ ml}$



$$\text{mmol C}_2\text{O}_4^{2-} \equiv \frac{0.8}{170} \times 1000 = \frac{80}{17} \Rightarrow \text{mmol MnO}_4^- \equiv \frac{80}{17} \times \frac{2}{5} = 40 \times M_{\text{KMnO}_4}$$

(i)
$$N_{\text{KMnO}_4} = 5M_{\text{KMnO}_4} = \frac{4}{17} N = 0.235N$$

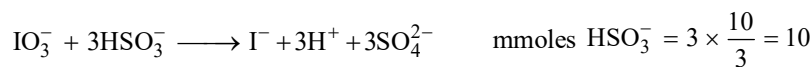
(ii)
$$\text{Strength} = NE = 0.235 \times \frac{158}{5} = 7.43 \text{ g/L}$$



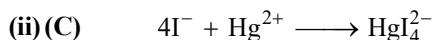
Moles of $\text{Cr}_2\text{O}_7^{2-} = 8.76 \times 0.05 \Rightarrow$ mmoles $\text{C}_2\text{H}_5\text{OH} = \frac{1}{2} \times 8.76 \times 0.05 = 0.219 \text{ mmol C}_2\text{H}_5\text{OH} = 0.01 \text{ g C}_2\text{H}_5\text{OH}$

\Rightarrow % of alcohol level = $\frac{0.01}{10} \times 100 = 0.1\%$

9. (i) (D) $\text{mmoles IO}_3^- = \frac{0.66}{198} \times 1000 = \frac{10}{3}$



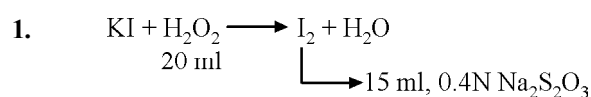
\Rightarrow amount of $\text{NaHSO}_3 = 10 \times 10^{-3} \times 104 = 1.04 \text{ gm}$



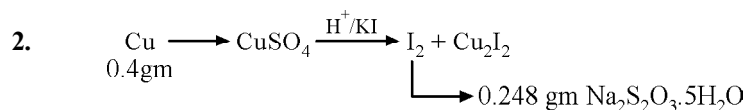
1 mol 1 mol



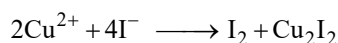
EXERCISE-C



$$\text{Meq Na}_2\text{S}_2\text{O}_3 = 0.4 \times 15 = 6 = \text{Meq. I}_2 = \text{Meq. H}_2\text{O}_2 = 20 \times N_{\text{H}_2\text{O}_2} \Rightarrow N_{\text{H}_2\text{O}_2} = \frac{6}{20} \Rightarrow \text{Vol. Strength of H}_2\text{O}_2 = \frac{6}{20} \times 5.6 = 1.68$$

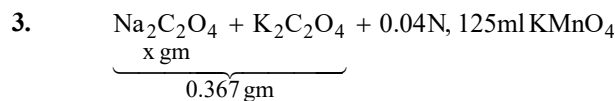


$$\text{Mmoles Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O} = \frac{0.248}{248} \times 1000 = 1 \Rightarrow \text{Mmoles I}_2 = 1 \times \frac{1}{2} \quad [\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \xrightarrow{\text{H}^+} \text{I}^- + \text{S}_4\text{O}_6^{2-}]$$



$$\Rightarrow 1 \text{ mmol I}_2 \equiv 2 \text{ mmol Cu}^{2+} \Rightarrow \text{Mmoles Cu}^{2+} = 2 \times \frac{1}{2} = 1 = \text{Mmoles Cu} \Rightarrow g_{\text{Cu}} = 10^{-3} \times 63.5 = 0.0635$$

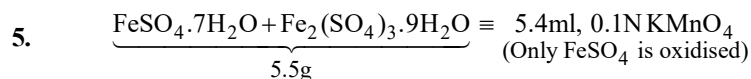
$$\% \text{Cu} = \frac{0.0635}{0.4} \times 100\% = 15.87\%$$



$$\Rightarrow \text{Meq. O.A.} = \text{Meq. R.A.} \Rightarrow 0.04 \times 125 = \left[\frac{x}{134/2} + \frac{0.367-x}{166/2} \right] \times 1000 \Rightarrow x = 0.2 \text{ gm}$$

$$\Rightarrow \% \text{Na}_2\text{C}_2\text{O}_4 = \frac{0.2}{0.367} \times 100\% = 54.7\%$$

4. $\text{Meq. KMnO}_4 = (0.1 \times 5) \times V = \text{Meq. Na}_2\text{S}_2\text{O}_3 = \frac{0.158}{158/1} \times 1000 \Rightarrow V = 2 \text{ ml}$

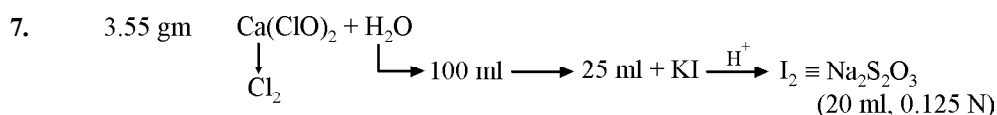


$$\Rightarrow \text{Meq. FeSO}_4 \cdot 7\text{H}_2\text{O} = 0.1 \times 5.4 = 0.54 \Rightarrow g_{\text{FeSO}_4 \cdot 7\text{H}_2\text{O}} = \frac{0.54 \times 278}{1000} = 0.15$$

$$\Rightarrow g_{\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}} = 5 - 0.15 = 5.35\text{gm} \Rightarrow \text{Moles Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O} = \frac{5.35}{562} = 9.52 \times 10^{-3}$$

6. $\text{Fe}(\text{HC}_2\text{O}_4)_2 : M_0 = 234$ (i) Acid : $2\text{H}^+ \Rightarrow n\text{-factor} = 2 \Rightarrow E = \frac{234}{2} = 117$

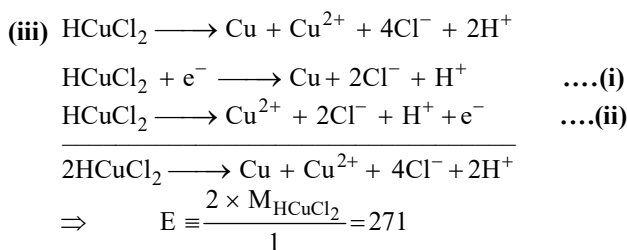
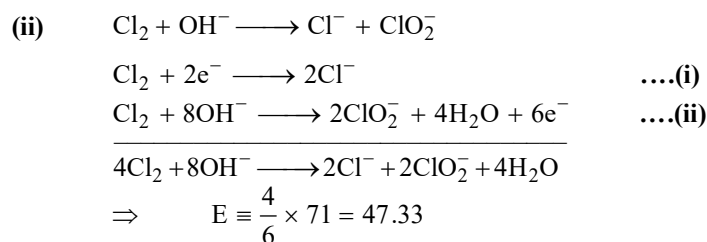
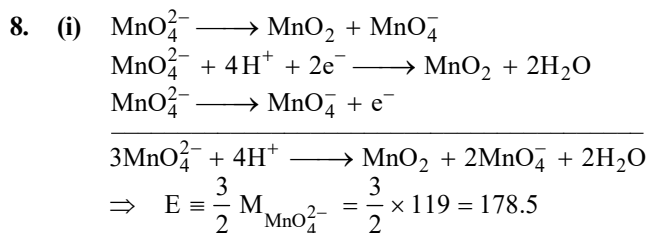
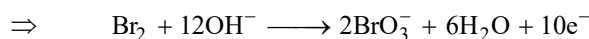
(ii) R.A. : $n\text{-factor} = 5 \Rightarrow E = \frac{234}{5} = 46.8$ $\left[\begin{array}{l} \text{HC}_2\text{O}_4^- \longrightarrow 2\text{CO}_2 + \text{H}^+ + 2\text{e}^- \\ \text{Fe}^{2+} \longrightarrow \text{Fe}^{3+} + \text{e}^- \end{array} \right]$



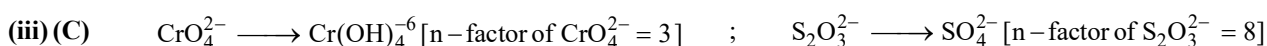
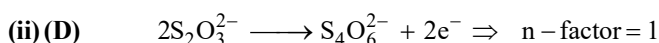
$$\text{Meq Na}_2\text{S}_2\text{O}_3 = 0.125 \times 20 = 2.5 = \text{Meq Cl}_2(\text{in } 25 \text{ ml}) \Rightarrow \text{Meq Cl}_2 = 2.5 \times 4 = 10$$

(in 100 ml)

$$\Rightarrow \frac{g}{71/2} \times 1000 = 10 \Rightarrow g = 0.355 \Rightarrow \% \text{ of available Cl}_2 = \frac{0.355}{3.55} \times 100\% = 10\%$$



9. (i) (B) $\text{Meq KMnO}_4 = \text{Meq H}_2\text{O}_2 \Rightarrow 10 \times \frac{10}{5.6} = \frac{g}{158/5} \times 1000 \Rightarrow g = 0.563\text{gm}$



$$\Rightarrow (0.1 \times 3) \times V = (0.25 \times 8) \times 40 \Rightarrow V = \frac{800 \text{ ml}}{3}$$

