⊛ Balance the redox rxn by ion-electron method:-

Question: (a) State what happens when potassium permanganet is treated with ferus sulphate in acid medium.

Ans: (a) In aqueous acid medium potassium permanganet ($KMnO_4$) oxidises $FeSO_4$ to $Fe_2(SO_4)_3$ and itself reduces to Mn^{2+} salt. Hence the molecular unbalanced equn can be written as

$$KMnO_4 + FeSO_4 \longrightarrow MnSO_4 + Fe_2(SO_4)_3 + K_2SO_4$$

(In H_2SO_4 medium).

(b) The ionic form of this molecular equn can be written as

$$MnO_4^- + Fe^{2+} \longrightarrow Mn^{2+} + Fe^{3+}$$

This ionic equn can be broken into oxidation and reduction half rxns as -

$$MnO_4^- \longrightarrow Mn^{2+} \quad \text{(reduction)}$$

$$Fe^{2+} \longrightarrow Fe^{3+} \quad \text{(oxidation)}$$

(c) Hence the balanced partial equn will be

$$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O \quad \ldots\ldots (i)$$

and $$Fe^{2+} \longrightarrow Fe^{3+} + e \quad \ldots\ldots (ii)$$

Multiplying equn no. (i) by 1 and (ii) by 5 and adding them we get,

$$MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$$

$$5Fe^{2+} \longrightarrow 5Fe^{3+} + 5e$$

$$MnO_4^- + 8H^+ + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 4H_2O + 5Fe^{3+}$$

This is the balanced equn in ionic form.

Or, $2KMnO_4 + 8H_2SO_4 + 10FeSO_4 = 2MnSO_4 + 8H_2O + 5Fe_2(SO_4)_3 + K_2SO_4$ (in mol. form)

(b) Potassium dicromate is treated with potassium iodide in dilute acid medium.

Ans: (a) In aqueous acid medium $K_2Cr_2O_7$ oxidises KI to I_2 and itself reduces to Cr^{3+} salt.

Hence the molecular unbalanced equn can be written as

$$K_2Cr_2O_7 + KI \longrightarrow I_2 + Cr_2(SO_4)_3 \quad \text{(In } H_2SO_4 \text{ medium)}$$

(b) The ionic form of this molecular equn can be written as

$$Cr_2O_7^{=} + I^- \longrightarrow I_2 + Cr^{3+}$$

This ionic equn can be broken into oxidation and reduction half-rxns as -

$Cr_2O_7^{=} \longrightarrow Cr^{3+}$ (reduction)

$I^- \longrightarrow I_2$ (oxidation)

(c) Hence the balanced partial equn will be

$Cr_2O_7^{=} + 14H^+ + 6e \longrightarrow 2Cr^{3+} + 7H_2O$ ------ (i)

and

$2I^- \longrightarrow I_2 + 2e$ ---------- (ii)

Multiplying equn no. (i) by 1 and equn no. (ii) by 3 and adding them, we get,

$Cr_2O_7^{=} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$

$6I^- \longrightarrow 3I_2 + 6e$

$Cr_2O_7^{=} + 14H^+ + 6I^- = 2Cr^{3+} + 7H_2O + 3I_2$

This is the balance equn in ionic form.

(d) The balance molecular equn will be

$K_2Cr_2O_7 + 7H_2SO_4 + 6KI = Cr_2(SO_4)_3 + 7H_2O + 3I_2 + 4K_2SO_4$

Q. (3) Potassium permanganet is treated with ~~hydrogen~~ sodium ~~stanide~~ ~~peroxide~~ in alkaline ~~acid~~ medium.

Ans. (a) In aqueous alkaline medium $KMnO_4$ oxidises sodium stanite (Na_2SnO_2) to sodium stanate (Na_2SnO_3) and itself reduces to Mn^{2+} salt.

Hence the molecular unbalance equn can be written as

$KMnO_4 + Na_2SnO_2 \longrightarrow MnO_2 + Na_2SnO_3$ (in alkaline medium)

(b) The ionic form of the molecular equn can be written as

$\overset{+7}{Mn}O_4^- + \overset{+2}{Sn}O_2^{=} \longrightarrow \overset{4+}{Mn}O_2 + \overset{+4}{Sn}O_3^{=}$

The ionic equn can be broken into oxidation and reduction half rxns as

$\overset{+7}{Mn}O_4^- \longrightarrow \overset{4+}{Mn}O_2$ (reduction)

$\overset{+2}{Sn}O_2^{=} \longrightarrow \overset{+4}{Sn}O_3^{=}$ (oxidation)

(c) Hence the balanced partial equn is

$MnO_4^- \rightarrow MnO_2 + 2H_2O$ (to balance the O atoms)

$\Rightarrow MnO_4^- + 4H^+ \rightarrow MnO_2 + 2H_2O$ (to balance the H atoms)

$\Rightarrow MnO_4^- + 2H_2O \rightarrow MnO_2 + 4OH^-$ (in alkaline medium)

$\Rightarrow MnO_4^- + 2H_2O + 3e \rightarrow MnO_2 + 4OH^-$ (to balance electrical charges) ....(i) $\times 4$

$SnO_2^= \rightarrow SnO_3^=$

$\Rightarrow SnO_2^= + 2H_2O \rightarrow SnO_3^=$ (to balance O atoms)

$\Rightarrow SnO_2^= + 2H_2O \rightarrow SnO_3^= + 4H^+$ (to balance H atoms)

$\Rightarrow SnO_2^= + 2H_2O + 4OH^- \rightarrow SnO_3^= + 4H_2O$ (in alkaline medium)

$\Rightarrow SnO_2^= + 4OH^- \rightarrow SnO_3^= + 2H_2O + 4e$ (to balance the electrical charges) ....(ii) $\times 3$

Adding (i) and (ii), we get,

$4MnO_4^- + 8H_2O + 12e \rightarrow 4MnO_2 + 16OH^-$

$3SnO_2^= + 12OH^- \rightarrow 3SnO_3^= + 6H_2O + 12e$

$4MnO_4^- + 2H_2O + 3SnO_2^= = 4MnO_2 + 4OH^- + 3SnO_3^=$

This is the balanced equn in ionic form.

$2KMnO_4 + H_2O + 3Na_2SnO_2 = 2MnO_2 + 2KOH + 3Na_2SnO_3$ (in mol. form).

Q: potassium ferrocyanide is treated with hydrogen peroxide in acid medium.

Ans:- (a) $K_4[Fe(CN)_6] \xrightarrow{+H_2O_2} K_3[Fe(CN)_6] + H_2O$ (in acid medium)

oxidation

$\Rightarrow [Fe^{+2}(CN)_6]^{4-} + H_2O_2 \rightarrow [Fe^{+3}(CN)_6]^{3-} + H_2O^{-2}$

reduction

The above equn can be broken into two partial equns

$[Fe^{+2}(CN)_6]^{4-} \rightarrow [Fe^{+3}(CN)_6]^{3-}$ (oxidation)

$H_2O_2^{-1} \rightarrow H_2O^{-2}$ (reduction)

(b) $[Fe(CN)_6]^{4-} \rightarrow [Fe(CN)_6]^{3-} + e$ (to balance the electrical eqn) ...(i) $\times 2$

(c) $H_2O_2 \rightarrow H_2O + H_2O$ (to balance the O atoms)

$\Rightarrow H_2O_2 + 2H^+ \rightarrow 2H_2O$ (to balance the H atoms)

$\Rightarrow H_2O_2 + 2H^+ + 2e \rightarrow 2H_2O$ ...(ii) $\times 1$

Adding (i) and (ii), we get,

$2[Fe(CN)_6]^{4-} \rightarrow 2[Fe(CN)_6]^{3-} + 2e$

$H_2O_2 + 2H^+ + 2e \rightarrow 2H_2O$

$2[Fe(CN)_6]^{4-} + H_2O_2 + 2H^+ = 2[Fe(CN)_6]^{3-} + 2H_2O$

This is the balanced equn in ionic form.

$\Rightarrow 2K_4[Fe(CN)_6]^{4-} + H_2O_2 + H_2SO_4 = 2K_3[Fe(CN)_6]^{3} + 2H_2O$ (in solution)

Balance the redox rxn by ion electron method

Questions (1)

(a) $FeCl_3 + SnCl_2 \rightarrow FeCl_2 + SnCl_4$

The above equation is broken into two partial equns.

$Fe^{3+} \rightarrow Fe^{2+}$ (reduction)

$Sn^{2+} \rightarrow Sn^{4+}$ (oxidation)

(b) $Fe^{3+} + e \rightarrow Fe^{2+}$ ---- (i) $\times 2$

$Sn^{2+} \rightarrow Sn^{4+} + 2e$ ---- (ii) $\times 1$ } to balance electrical charges.

Adding (i) and (ii) we get,

$2Fe^{3+} + 2e \rightarrow 2Fe^{2+}$

$Sn^{2+} \rightarrow Sn^{4+} + 2e$

$2Fe^{3+} + Sn^{2+} \rightleftharpoons 2Fe^{2+} + Sn^{4+}$

ie, $2FeCl_3 + SnCl_2 = 2FeCl_2 + SnCl_4$

(2) (a) $P_4 \rightarrow H_2PO_2^- + PH_3$ (in alkaline medium)

The above equation is broken into two partial equns.

$P_4 \rightarrow \overset{+1}{H_2PO_2^-}$ (oxidation)

$P_4 \rightarrow \overset{-3}{PH_3}$ (reduction)

(b) $P_4 \rightarrow 4H_2PO_2^-$ (to balance 'P' atoms)

$\Rightarrow P_4 + 8H_2O \rightarrow 4H_2PO_2^-$ (to balance 'O' atoms)

$\Rightarrow P_4 + 8H_2O \rightarrow 4H_2PO_2^- + 8H^+$ (to balance 'H' atoms)

$\Rightarrow P_4 + 8H_2O + 8OH^- \rightarrow 4H_2PO_2^- + 8H^+ + 8OH^-$ (in alkaline med

$\Rightarrow P_4 + 8OH^- \rightarrow 4H_2PO_2^- + 4e$ (to balance electrical charges)

---- (i) $\times 3$

(c) $P_4 \rightarrow PH_3$

$\Rightarrow P_4 \rightarrow 4PH_3$ (to balance the 'P' atoms)

$\Rightarrow P_4 + 12H^+ \rightarrow 4PH_3$ (to balance 'H' atoms)

$\Rightarrow P_4 + 12H^+ + 12OH^- \rightarrow 4PH_3 + 12OH^-$ (in alkaline me

$\Rightarrow P_4 + 12H_2O \rightarrow 4PH_3 + 12OH^-$

$\Rightarrow P_4 + 12H_2O + 12e \rightarrow 4PH_3 + 12OH^-$ (to balance the electrical charges)

---- (ii) $\times 1$

Adding (i) and (ii) we get,

$3P_4 + 24OH^- \rightarrow 12H_2PO_2^- + 12e$

$P_4 + 12H_2O + 12e \rightarrow 4PH_3 + 12OH^-$

$4P_4 + 24OH^- + 12H_2O = 12H_2PO_2^- + 4PH_3 + 12OH^-$