Question

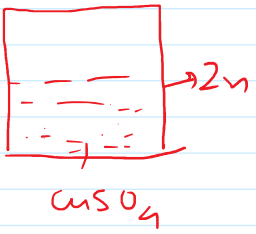
Can you store copper sulphate solution in zinc pot?

Answer

$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

oxidation



$E^\circ_{Cu^{2+}/Cu} = 0.34\,V$ $\quad E^\circ_{Zn^{2+}/Zn} = -0.76\,V$

$E^\circ_{reaction} = E^\circ_{cathode} - E^\circ_{anode}$

$= 0.34 - (-0.76) = 1.1\,V$

as $E^\circ_{reaction} > 0$, the reaction is spontaneous hence copper sulphate solution cannot be stored in zinc pot

Question.

Consult the table of standard electrode potentials and suggest three substances that can oxidise ferrous ions under suitable conditions

Ans:

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ $\quad E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77\,V$

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

$E^\circ_{reaction} = E^\circ_{cathode} - E^\circ_{anode} > 0$ (for spontaneity)

$E^\circ_{substance} - E^\circ_{Fe^{3+}/Fe^{2+}} > 0$

$E^\circ_{substance} > E^\circ_{Fe^{3+}/Fe^{2+}}$

$> 0.77\,V$

F_2, Cl_2, I_2 are such substance.

Question.

Using the standard electrode potentials, predict if the reaction between the following is feasible:

i) $Fe^{3+}(aq)$ and $I^-(aq)$

ii) $Ag^+(aq)$ and $Cu(s)$

iii) $Fe^{3+}(aq)$ and $Br^-(aq)$

iv) $Ag(s)$ and $Fe^{3+}(aq)$

v) $Br_2(aq)$ and $Fe^{2+}(aq)$

Answer.

i) $(Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq))\times 2$ $\quad E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77V$

$2I^-(aq) \rightarrow I_2(s) + 2e^-$ $\quad E^\circ_{I^-/I_2} = -0.54V$

$2Fe^{3+} + 2I^- \rightarrow I_2 + 2Fe^{2+}$ $\quad E^\circ_{reaction} = 0.23V$

$E^\circ_{reaction} = E^\circ_{reduction} + E^\circ_{oxidation}$

$= 0.77 - 0.54$

$= 0.23V$

as $E^\circ_{reaction} > 0$, the reaction is spontaneous.

ii) $[Ag^+(aq) + e^- \rightarrow Ag(s)]\times 2$ $\quad E^\circ_{Ag^+/Ag} = 0.8V$

$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ $\quad E^\circ_{Cu/Cu^{2+}} = -0.34V$

$2Ag^+ + Cu \rightarrow Cu^{2+} + 2Ag$

$E^\circ_{reaction} = E^\circ_{reduction} + E^\circ_{oxidation}$

$= E^\circ_{Ag^+/Ag} + E^\circ_{Cu/Cu^{2+}}$

$= 0.8 - 0.34$

$= 0.46V$

as $E^\circ_{reaction} > 0$, the reaction is spontaneous.

iii) $\left(Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq) \right) 2$ $\quad E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77V$

$2Br^-(aq) \rightarrow Br_2(l) + 2e^-$ $\quad E^\circ_{Br^-/Br_2} = -1.09V$

$2Fe^{3+}(aq) + 2Br^-(aq) \rightarrow 2Fe^{2+}(aq) + Br_2(l)$

$E^\circ_{reaction} = E^\circ_{reduction} + E^\circ_{oxidation}$

$= 0.77 - 1.09$

$= -0.32V$

as $E^\circ_{reaction} < 0$, the reaction is non spontaneous

iv) $Ag(s) \rightarrow Ag^+(aq) + e^-$ $\quad E^\circ_{Ag/Ag^+} = -0.80V$

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $\quad E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77V$

$Ag(s) + Fe^{3+}(aq) \rightarrow Ag^+(aq) + Fe^{2+}(aq)$

$E^\circ_{reaction} = E^\circ_{reduction} + E^\circ_{oxidation}$

$= E^\circ_{Fe^{3+}/Fe^{2+}} + E^\circ_{Ag/Ag^+}$

$= 0.77 - 0.80$

$= -0.03V$

as $E^\circ_{reaction} < 0$, reaction is non spontaneous.

v) $Br_2(aq) + 2e^- \rightarrow 2Br^-(aq)$ $\quad E^\circ_{Br_2/Br^-} = 1.09V$

$\left(Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^- \right) 2$ $\quad E^\circ_{Fe^{2+}/Fe^{3+}} = -0.77V$

$Br_2(aq) + 2Fe^{2+}(aq) \rightarrow 2Br^-(aq) + 2Fe^{3+}(aq)$

$E^\circ_{reaction} = E^\circ_{oxidation} + E^\circ_{reduction}$

$= E^\circ_{Fe^{2+}/Fe^{3+}} + E^\circ_{Br_2/Br^-}$

$= -0.77V + 1.09V$

$= 0.32V$

as $E^\circ_{reaction} > 0$, the process is spontaneous