22/04/21

Electrochemistry problems

Formula

(1) EMF of a cell

$$E_{cell} = E^{\circ}_{cell} - \frac{2.303\,RT}{nF} \log \frac{[Pdt]}{[Rct]}$$

(2) Electrode reduction Potential

$$E_{ele} = E^{\circ}_{ele} - \frac{2.303\,RT}{nF} \log \frac{[Pdt]}{[Rct]}$$

(3) Electrolyte Concentration cell

$$EMF = \frac{2.303\,RT}{nF} \log \frac{C_2}{C_1} \frac{[High]}{[Low]}$$

(4) Electrode Concentration Cell

$$EMF = \frac{2.303\,RT}{nF} \log \frac{C_1}{C_2} \frac{[High]}{[Low]}$$

(5) Reaction Feasibility

$$\Delta G = -nFE$$

$$\Delta G^0 = -nFE^\circ$$

(6) Equilibrium Constant

$$K = 10^{nFE^\circ_{cell}/2.303RT}$$

$$\log_{10} K = \frac{nFE^\circ_{cell}}{2.303\,RT}$$

(7) $$E^\circ_{cell} = E^\circ_{RHS} - E^\circ_{LHS}$$

$$EMF = E_{cell} = E_{RHS} - E_{LHS}$$

1) Calculate the emf of the following cell

$Zn/Zn^{2+}(1m) \,//\, Cu^{2+}(2m)/Cu(s)$

Given that $E^\circ_{Zn/Zn^{2+}} = +0.76$ volt $\quad E^\circ_{(Cu^{2+}/Cu(s)} = 0.34\,V$

$E^\circ_{Zn^{2+}/Zn} = -0.76V$

Ans :-

$Zn/Zn^{2+}(1m) \,//\, Cu^{2+}(2m)/Cu(s)$.

$$E_{cell} = E^\circ_{cell} - \frac{2.303\,RT}{nF} \log \frac{[Pdt]}{[Rect]}$$

Anode : $Zn \longrightarrow Zn^{2+} + 2e^-$

Cathode : $Cu^{2+} + 2e^- \longrightarrow Cu(s)$

Net : $Zn + Cu^{2+} \longleftrightarrow Zn^{2+} + Cu(s)$ $\quad n = 2$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{n} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

$$E^\circ_{cell} = E^\circ_{RHS} - E^\circ_{LHS}$$

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

$$= 0.34 - (-0.76)$$

$$E^\circ_{cell} = 1.1\,V.$$

$$E_{cell} = 1.1 - \frac{0.0591}{2} \log \frac{[1]}{[2]}$$

0.0295

$$= 1.1 - \frac{0.0591}{2} (-0.3010)$$

$$= 1.1 - (-8.89 \times 10^{-3})$$

$\frac{}{10^{-3}} + 8.89 \times 10^{-3}$

$= 10^{-3} (1.1 \times 10^{3} + 8.89)$

$= 10^{-3} (1100 + 8.89)$

$= 1,108.8 \times 10^{-3}$

$= 1.108 \times 10^{3} \times 10^{-3}$

$E_{cell.} = 1.108\ V.$

2) Calculate the reduction electrode potential of copper electrode when its dipped in a 5M $CuSO_4$ solution. Given that $E^{\circ}_{Cu^{2+}/Cu} = 0.34\ V.$

$$E_{ele} = E^{\circ}_{ele} - \frac{0.0591}{n} \log \frac{[Pdt]}{[Red]}$$

$Cu^{2+} + 2e^{-} \rightarrow Cu(s) \quad n = 2$

$$= E^{\circ}_{ele} - \frac{0.0591}{2} \log \frac{[Cu]}{[Cu^{2+}]}$$

$$= E^{\circ}_{ele} - \frac{0.0591}{2} \log \frac{[1]}{[Cu^{2+}]}$$

$$= 0.34\ V - \frac{0.0591}{2} \log \frac{1}{[5]}$$

$$= 0.34 - \frac{0.0591}{2} (-0.698)$$

$$= 0.34 + \frac{0.0412}{2}$$

$$= 0.34 + 0.020$$

$E_{ele} = 0.36\ V.$

(3) Calculate the eqm constant for the rexn at 298 K

$$Cu_{(s)} + 2Ag^{+}_{(aq)} \longleftrightarrow Cu^{2+}_{(aq)} + 2Ag$$

Given that

$$E^{\circ}_{Cu/Cu^{2+}} = -0.34 \qquad E^{\circ}_{Ag^{+}/Ag} = 0.80\ V$$

$$\log K = \frac{nFE^{\circ}}{2.303RT} = \frac{2 \times 96500 \times 0.46}{8.314 \times 298 \times 2.303}$$

$$E^{\circ} = E^{\circ}_{Ag^{+}/Ag} - E^{\circ}_{Cu^{2+}/Cu} = 0.80 - 0.34 = 0.46\ V$$

$$K = 10^{15.57} = 3.68 \times 10^{15}$$

Calculate the equation equilibrium constant at 25°c (298 K) for the cell $Fe_{(s)}/Fe^{2+} // Ni^{2+}/Ni$

Given that $E^{\circ}_{Fe^{2+}/Fe} = 0.44\ V$ $E^{\circ}_{Ni^{2+}/Ni} = -0.24\ V$

$$E^{\circ}_{cell} = E^{\circ}_{RHS} - E^{\circ}_{LHS}$$

$$Fe/Fe^{2+} // Ni^{2+}/Ni^{\circ}$$

$$Fe \longrightarrow Fe^{2+} + 2e^-$$

$$Ni^{2+} + 2e^- \longrightarrow Ni^{\circ}$$

$$Fe + Ni^{2+} \longleftrightarrow Fe^{2+} + Ni^{\circ}$$

$$n = 2$$

$$E^{\circ}_{cell} = -0.24 - 0.44$$

$$E^{\circ}_{cell} = -0.68$$

$$\log K = \frac{n E^{\circ}_{cell}}{0.0591}$$

$$\log k = \frac{2 \times (-0.68)}{0.0591}$$

$$\log K = \frac{-1.36}{0.0591}$$

$$\log k = -23.01$$

$$k = \text{Antilog}\ (-23.01)$$

$$k = 9.77 \times 10^{-24}$$

A cell is constructed by inserting a silver electrode in (0.01 m) & (10 m) $AgNO_3$ solution Given that $E^{\circ}_{Ag^+/Ag} = +0.80\ V$. Write the cell representation and electrode rxn and calculate the emf of the cell.

A cell is constructed by inserting a silver electrode in (0.01 m) & (10 m) $AgNO_3$ solution Given that $E^{\circ}_{Ag^+/Ag} = +0.80\ V$. Write the cell representation and electrode rxn and calculate the emf of the cell.

Calculate the EMF of the following cell

$Al / Al^{3+}_{(3M)} \,||\, Cu^{2+}_{(3M)} / Cu_{(s)}$

Gn that $E^\circ_{Al/Al^{3+}} = 1.76\ V$ $E^\circ_{Cu^{2+}/Cu} = 0.34\ V$.

$$2Al \longrightarrow 2Al^{3+} + 6e^-$$

$$3Cu^{2+} + 6e^- \longrightarrow 3Cu_{(s)}$$

$$2Al + 3Cu^{2+} \longleftrightarrow 2Al^{3+} + 3Cu. \qquad n = 6.$$

$$E^\circ_{cell} = E^\circ_{Cu^{2+}/Cu} - E^\circ_{Al/Al^{3+}}$$

$$= 0.34 - (-1.76)$$

$$= 0.34 + 1.76$$

$$E^\circ_{cell} = 2.1\ V$$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{n=6} \log \frac{[Al^{3+}]^2}{[Cu^{2+}]^3}$$

$$= 2.1 - 0.0291 \log \frac{[3]^2}{[3]^3} = \frac{1}{3}$$

$$= 2.1 - 0.0291 \times \log 3$$

$E_{cell} = 2.1\ V$ $E_{cell} =$