

22/04/21

## Electrochemistry problems

### Formula

① EMF of a cell

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

② Electrode reduction Potential

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

③ Electrolyte Concentration Cell

$$EMF = \frac{2.303 RT}{nF} \log \frac{c_2}{c_1} \frac{[\text{High}]}{[\text{Low}]}$$

④ Electrode Concentration Cell

$$EMF = \frac{2.303 RT}{nF} \log \frac{c_1}{c_2} \frac{[\text{High}]}{[\text{Low}]}$$

## (5) Reaction Feasibility

$$\Delta G = -nFE$$

$$\Delta G^{\circ} = -nFE^{\circ}$$

## (6) Equilibrium Constant

$$K = 10^{\frac{nFE_{\text{cell}}^{\circ}}{2.303RT}}$$

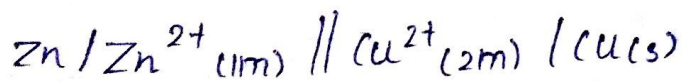
$$\log_{10} K = \frac{nFE_{\text{cell}}^{\circ}}{2.303RT}$$

## (7)

$$E_{\text{cell}}^{\circ} = E_{\text{RHS}}^{\circ} - E_{\text{LHS}}^{\circ}$$

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

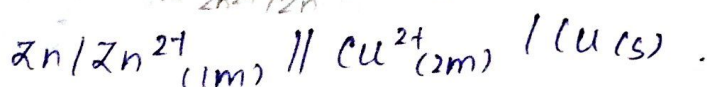
1) calculate the emf of the following cell



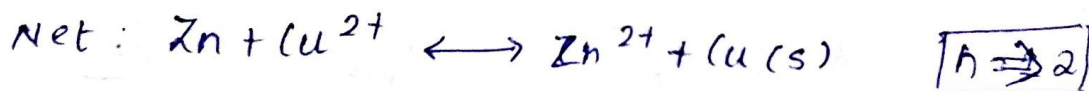
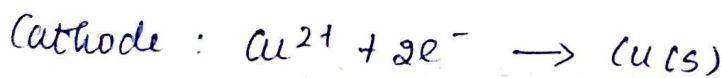
Given that  $E^\circ_{\text{Zn}/\text{Zn}^{2+}} = +0.76 \text{ volt}$   $E^\circ_{\text{Cu}^{2+}/\text{Cu (s)}} = 0.34 \text{ V}$

Ans :-

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



$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{2.303 RT}{nF} \log \frac{[\text{Prod}]}{[\text{React}]}$$



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

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

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

$$= 0.34 - (-0.76)$$

$$E^\circ_{\text{cell}} = 1.1 \text{ V}$$

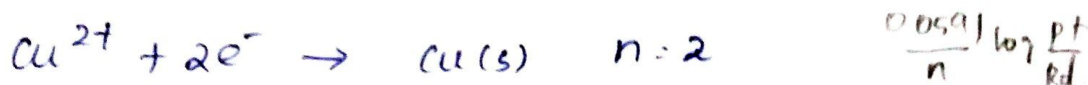
$$\begin{aligned} E_{\text{cell}} &= 1.1 - \frac{0.0591}{2} \log \frac{[1]}{[2]} \\ &= 1.1 - \frac{0.0591}{2} (-0.3010) \\ &= 1.1 - (-8.89 \times 10^{-3}) \end{aligned}$$

$$\begin{aligned}
 &= 10^{-3} (1.1 \times 10^{-3} + 8.89) \\
 &= 1.1088 \times 10^{-3} \\
 &= 1.108 \times 10^{-3} \times 10^{-3}
 \end{aligned}$$

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

2) Calculate the reduction electrode potential of copper electrode when its dipped in a 5M  $\text{CuSO}_4$  solution. Given that  $E^{\circ}_{\text{Cu}^{2+}/\text{Cu}} = 0.34 \text{ V}$ .

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



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

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

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

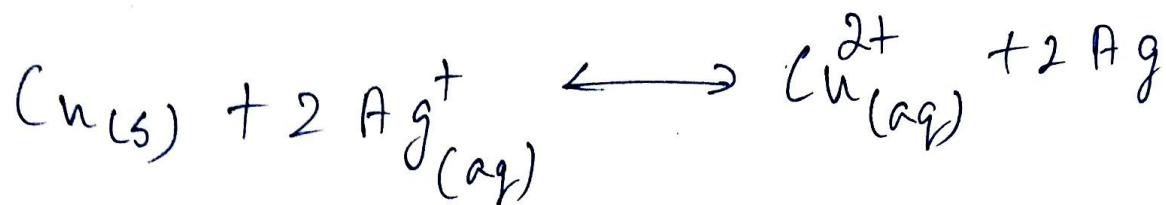
$$= 0.34 - \frac{0.0591}{2} (-0.698)$$

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

$$= 0.34 + 0.020$$

$$E_{\text{ele}} = 0.36 \text{ V.}$$

③ Calculate the eqm constant for the rxn at 298 K



Given that

$$E^0_{\text{Cu}/\text{Cu}^{2+}} = -0.34 \quad E^0_{\text{Ag}^+/\text{Ag}} = 0.80 \text{ V}$$

$$\log K = \frac{n F E^0}{2.303 R T} = \frac{2 \times 96500 \times 0.46}{8.314 \times 298 \times 2.303}$$

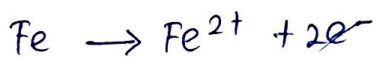
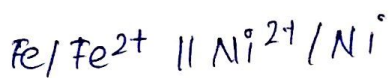
$$E^0 = E^0_{\text{Ag}^+/\text{Ag}} - E^0_{\text{Cu}^{2+}/\text{Cu}} = 0.80 - 0.34 = 0.46 \text{ V}$$

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



Calculate the ~~equation~~ equilibrium constant at  $25^{\circ}\text{C}$  ( $298\text{ K}$ ) for the cell  $\text{Fe(s)} / \text{Fe}^{2+} // \text{Ni}^{2+} / \text{Ni}$   
 Given that  $E^{\circ}_{\text{Fe}^{2+}/\text{Fe}} = 0.44\text{ V}$   $E^{\circ}_{\text{Ni}^{2+}/\text{Ni}} = -0.24\text{ V}$

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



$$n = 2$$

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

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

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

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

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

$$\log K = -23.01$$

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

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

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

A cell is constructed by inserting a silver electrode in (0.01M) & (10M)  $\text{AgNO}_3$  solution

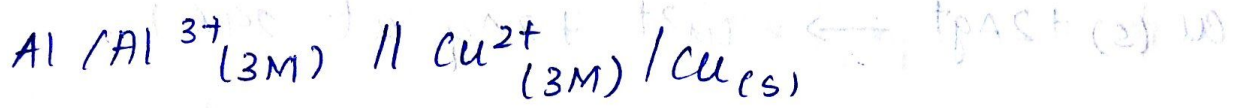
Given that  $E^{\circ}_{\text{Ag}^+/\text{Ag}} = +0.80 \text{ V}$ . Write the cell representation and electrode rxn and calculate the emf of the cell.

A cell is constructed by immersing a silver electrode in  $(0.01\text{M})$  &  $(10\text{M})$   $\text{AgNO}_3$  solution

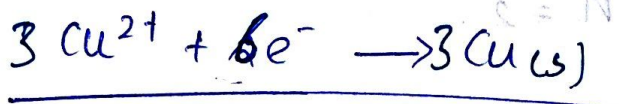
Given that  $E^\circ_{\text{Ag}^+/\text{Ag}} = +0.80\text{V}$ . Write the cell representation and electrode rxn and calculate the emf of the cell.



calculate the EMF of the following cell



Given that  $E^\circ_{\text{Al}/\text{Al}^{3+}} = -1.76 \text{ V}$   $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = 0.34 \text{ V}$



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

$$= 0.34 - (-1.76)$$

$$= 0.34 + 1.76$$

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

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

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

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

$$\cancel{E_{\text{cell}} = 2.1 \text{ V}} \quad E_{\text{cell}} =$$