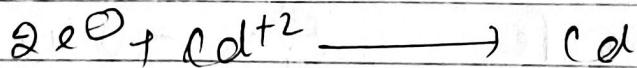
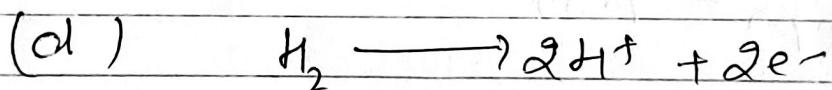
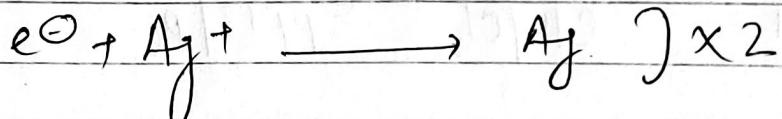
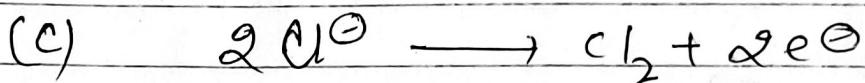
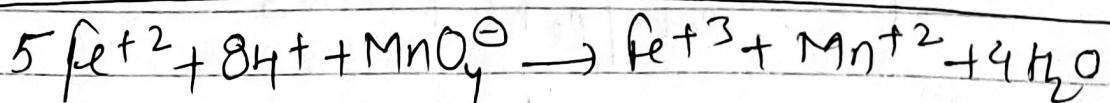
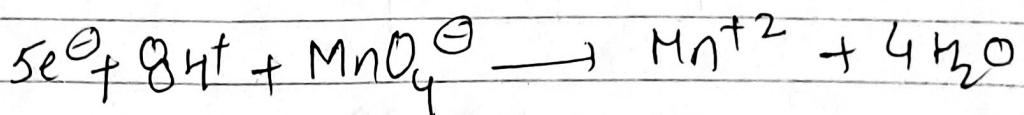
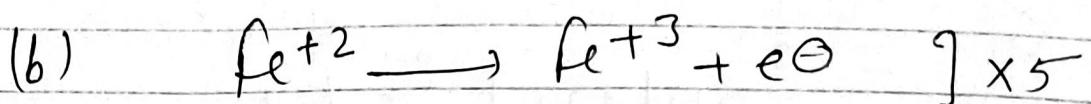
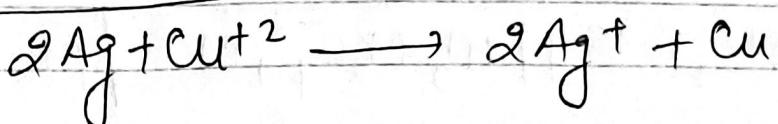
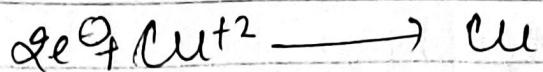
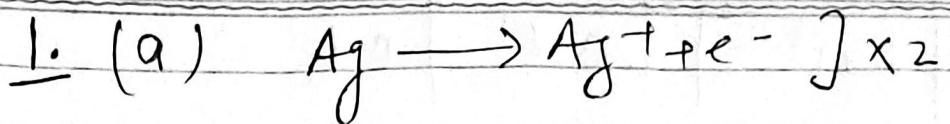
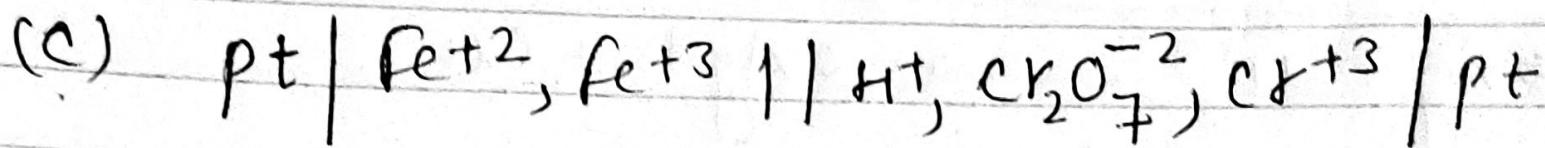
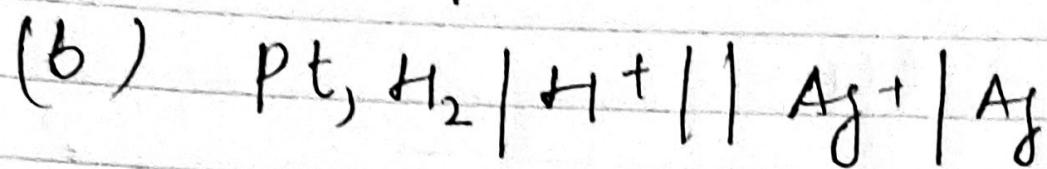
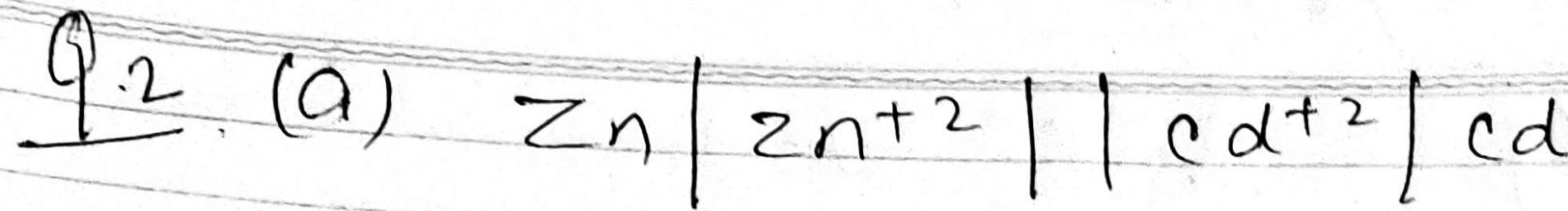


## Exercise 5-1

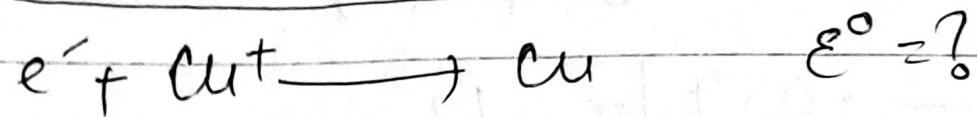
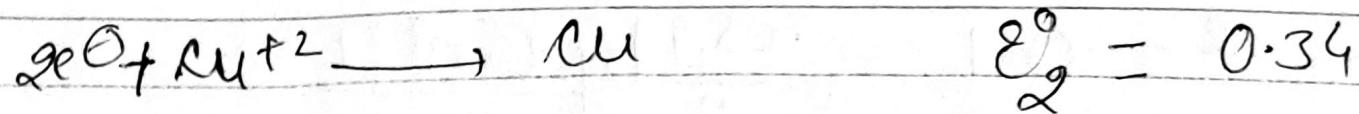
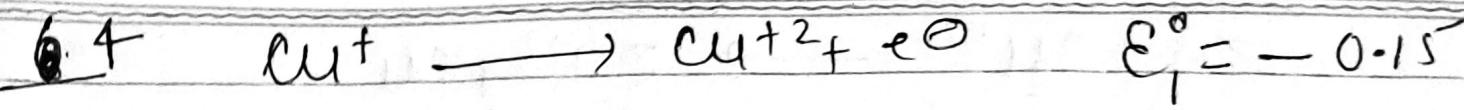




Q.3  $E_{\text{cell}}^\circ = E_{\text{Ce}^{+4}/\text{Ce}^{+3}}^\circ + E_{\text{Co}/\text{Co}^{+2}}^\circ$

$$1.89 = E_{\text{Ce}^{+4}/\text{Ce}^{+3}}^\circ + 0.28$$

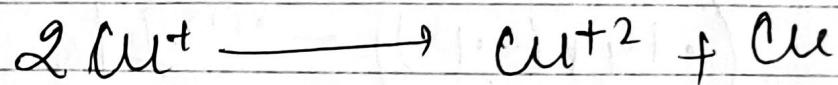
$$E_{\text{Ce}^{+4}/\text{Ce}^{+3}}^\circ = 1.61 \text{ volt}$$



$$E^\circ = \frac{1 \times (-0.15) + 2(0.34)}{1}$$

$$E^\circ = 0.53 \text{ volt}$$

$\Rightarrow$  for disproportion of  $\text{Cu}^+$

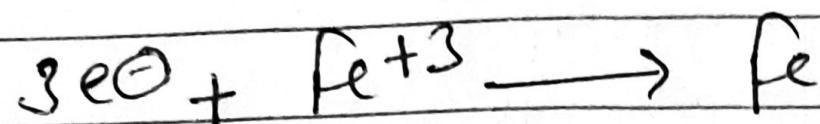
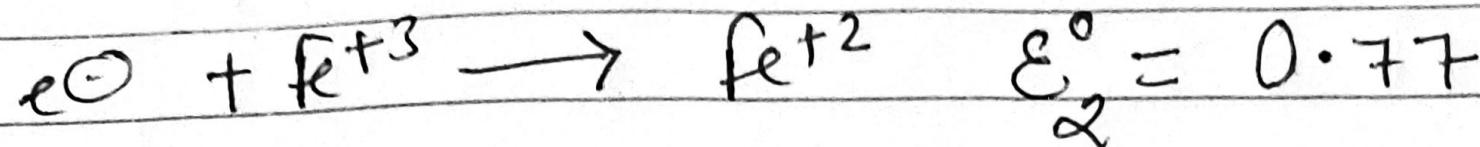
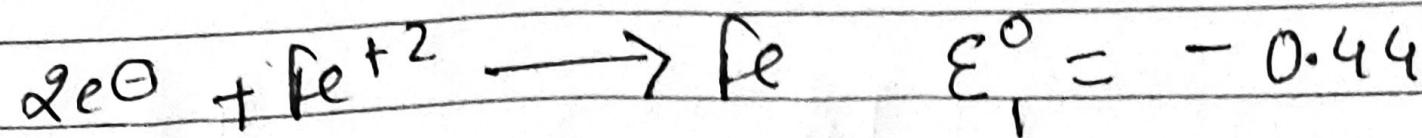


$$E^\circ = E^\circ_{\text{Cu}^+/\text{Cu}^{+2}} + E^\circ_{\text{Cu}^+/\text{Cu}}$$

$$= 0.34 - 0.15 + 0.53$$

$$E^\circ = 0.38$$

Q.5.

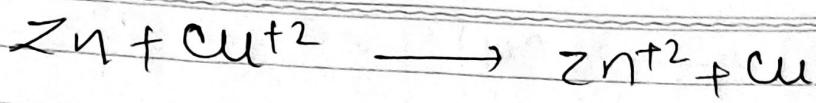


$$\mathcal{E}_{Fe^{+3}/Fe}^\circ = \frac{n_1 \mathcal{E}_1^\circ + n_2 \mathcal{E}_2^\circ}{n}$$

$$= \frac{2 \times (-0.44) + 1 \times (0.77)}{3}$$

$$= -0.03666$$

Q. 6



$$\mathcal{E} = 0.1 - \frac{0.059}{2} \log \frac{[\text{Zn}^{+2}]}{[\text{Cu}^{+2}]}$$

$$\mathcal{E} = 0.1 - \frac{0.059}{2} \log \frac{10^3}{10^1}$$

$$\mathcal{E} = 0.1 + 0.059 \Rightarrow \mathcal{E} = 0.159$$

Q. 7

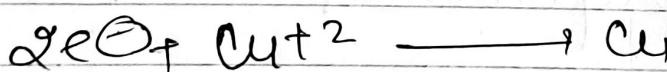


$$E_{\text{cell}} = (0.14 - (-0.13)) - \frac{0.059}{2} \log \frac{1}{10^3}$$

$$E_{\text{cell}} = -0.01 - 0.059 \Rightarrow E = -0.069 \text{ volt}$$

As  $E_{\text{cell}}$  is negative it means cell representation is incorrect

Q. 8



$$\mathcal{E} = +0.34 - \frac{0.059}{2} \log \frac{1}{[\text{Cu}^{+2}]}$$

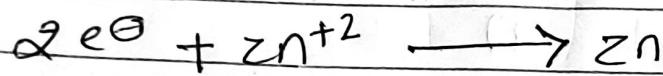
$$\log [\text{Cu}^{+2}] = -\frac{0.68}{0.059}$$

Q.9

$$\mathcal{E}^\circ_{\text{I}^\ominus/\text{AgI}/\text{Ag}} = \mathcal{E}^\circ_{\text{Ag}^+/\text{Ag}} + \frac{0.059}{n} \log K_{\text{sp}}$$

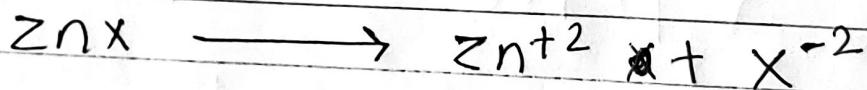
$$\begin{aligned}\mathcal{E}^\circ_{\text{I}^\ominus/\text{AgI}/\text{Ag}} &= 0.7991 + \frac{0.059}{1} \times (-16.07) \\ &= -0.149 \\ &\approx -0.15\end{aligned}$$

Q.10



$$E = -0.76 - \frac{0.059}{2} \log \frac{1}{[\text{Zn}^{+2}]}$$

Let zinc salt is  $\text{ZnX}$



0.1

-

-

0.1-x

x

x

$$x = 0.1 \times \frac{20}{100} = \frac{1}{50}$$

$$E = -0.76 - \frac{0.059}{2} \log 50$$

$$E = -0.81015$$

$$Q.11 \quad 0.44 + 0.337 = \frac{0.059}{2} \log K_{eq}$$

$$\log K_{eq} = 26.3389$$

$$K_{eq} = 10^{26.3389} = 2.18 \times 10^{26}$$

$$Q.12. \quad \mu = \frac{dE^\circ}{dT} = \frac{\Delta S^\circ}{nF}$$

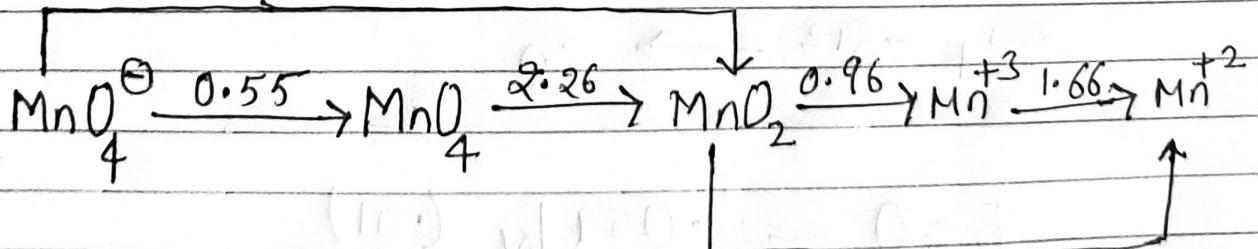
$$0.2 = \frac{\Delta S^\circ}{2 \times 96500}$$

$$\Delta S^\circ = 3860 \text{ Joule/Kelvin.}$$

$$\Delta S^\circ = 3.86 \text{ kJ/Kelvin.}$$

Q.13

$$E_1^\circ = \frac{1 \times 0.55 + 2 \times 2.26}{3} = 1.69 \text{ Volt}$$

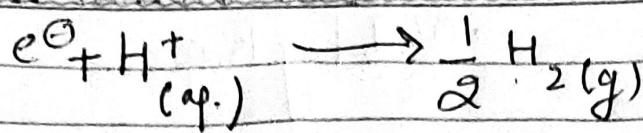


$$E_2^\circ = \frac{0.96 \times 1 + 1.66 \times 1}{2}$$

$$E_2^\circ = 1.31 \text{ Volt}$$

$$E_1^\circ + E_2^\circ = 1.69 + 1.31 = 3.0 \text{ Volt}$$

Q.14



$$E = 0 - \frac{0.059}{1} \log \frac{P_{H_2} \gamma_2}{[H^+]}$$

$$P_{H_2} = 1 \text{ atm}$$

$$E = - \frac{0.059}{1} \log \frac{1}{[H^+]}$$

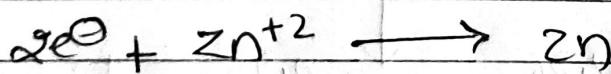
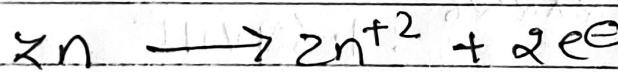
$$E = -0.059 (pH)$$

~~E = -0.059~~

$$-0.413 = -0.059 (pH)$$

$$pH = 7$$

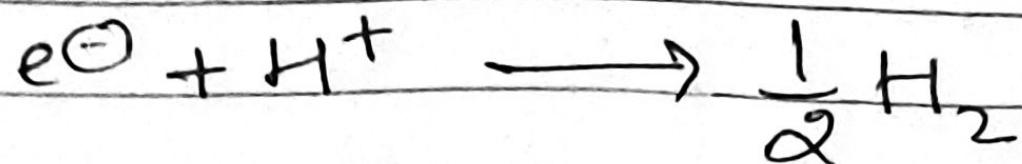
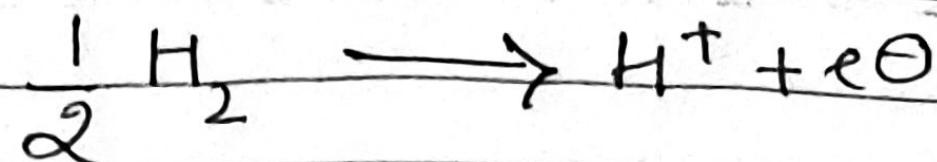
Q.15.



$$E = 0 - \frac{0.059}{2} \log \frac{(0.01)}{(0.1)}$$

$$E = 0.295 \text{ volt}$$

Q.16.



$$E = 0 - \frac{0.059}{1} \log x$$

$$0.2364 = -0.059 \log x$$

$$x = 10^{-4} \quad \text{so } \text{pH} = 4$$

## Electrolytic cell

(1)

~~Q.~~ (a)  $8 \cdot 71 \text{ e}^- = \text{mole of electron}$

$$\frac{3 \cdot 55}{35 \cdot 5} \times 1 = n_{e^-}$$

$$n_{e^-} = 0 \cdot 1 \text{ mole}$$

$$\begin{aligned} \text{Number of electrons} &= 0 \cdot 1 \times 6 \times 10^{23} \\ &= 6 \times 10^{22} \text{ electrons} \end{aligned}$$

(b)  $8 \cdot 91 \text{ e}^2 = \text{mole of electron}$

$$\frac{1}{63 \cdot 5} \times 2 = n_e$$

$$\begin{aligned} \text{number of } e^- &= \frac{2}{63 \cdot 5} \times 6 \times 10^{23} \\ &= 1 \cdot 89 \times 10^{22} \text{ electrons.} \end{aligned}$$

(c) Eq.  $\text{Al}^{+3} = \text{mole of } e^-$

$$\frac{2.7}{27} \times 3 = n_{e^-}$$

$$\begin{aligned}\text{Number of electrons} &= 0.3 \times 6 \times 10^{23} \\ &= 1.8 \times 10^{23} \text{ electrons}\end{aligned}$$

(18) (a) Eq. of  $\text{Al}^{+3} = \text{number of faradays}$

$$0.25 \times 3 = \text{number of faradays}$$

$$\text{number of faradays} = 0.75$$

(b) Eq.  $(\text{SO}_3) = \text{number of faradays}$

$$\frac{27.6}{80} \times 2 = \text{number of faradays}$$

$$\text{number of faradays} = 0.69$$

(c) Eq.  $\text{Cu}^{+2} = \text{number of faradays}$

$$1.1 \times 0.5 \times 2 = \text{number of faradays}$$

$$\text{Number of faradays} = 1.1 \text{ faraday}$$

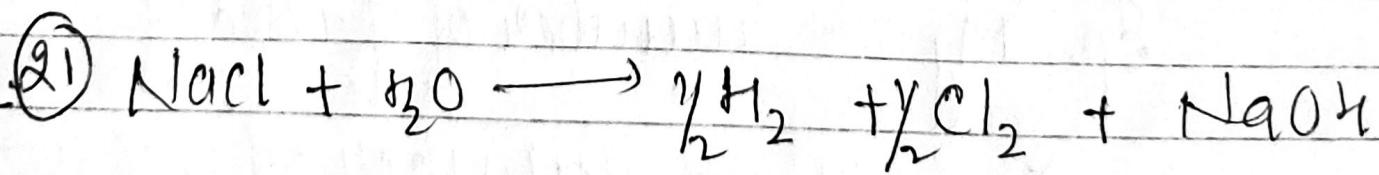
(19) ~~Eq.~~  $\text{Zn} = \text{Eq.}(\text{Ag}) = 0.5$

$$n_{\text{Zn}} \times 2 = n_{\text{Ag}} \times 1 = 0.5$$

$$\begin{aligned}\text{mass of Ag} &= 0.5 \times 108 \\ &= 54 \text{ gm}\end{aligned}$$

$$\begin{aligned}\text{mass of Zn} &= 0.25 \times 65 \\ &= 16.25 \text{ gm}\end{aligned}$$

$$\begin{aligned}
 \textcircled{20} \quad \text{Eq. } (\text{MnO}_2) &= \frac{It}{96500} \times \frac{85}{100} \\
 \frac{1000}{87} \times 2 &= \frac{25.5 \times t}{96500} \times \frac{85}{100} \\
 t &= \frac{2 \times 965 \times 10^7}{87 \times 25.5 \times 85} = 2 \times 5.12 \times 10^{-3} \times 10^7 \\
 &= 10.24 \times 10^4 \text{ second}
 \end{aligned}$$



$$\text{Eq. Cl}_2 = \frac{It}{96500}$$

$$\Rightarrow n_{\text{Cl}_2} \times 2 = \frac{30 \times 3600}{96500}$$

$$n_{\text{Cl}_2} = 0.56 \text{ mol}$$

Volume of  $\text{Cl}_2$  at 1 atm, 273 Kelvin temp

$$= 0.56 \times 22.4 = 12.544 \text{ lit}$$

produced mole of  $\text{NaOH} = 2 \times 0.56$

$$= 1.12 \text{ mol}$$

mass of  $\text{NaOH} = 1.12 \times 40$

$$= 44.8 \text{ gm}$$

Q.22  $\text{Eq. H}_2 = \text{Eq. O}_2$

$$\frac{P(0.224)}{RT} \times 2 = \frac{P}{RT} (V_{\text{O}_2}) \times 4$$

$$V_{\text{O}_2} = 0.112 \text{ litre}$$

Q.23  $\text{Eq. (Al)} = \text{no. of faradays}$

$$\left(\frac{x}{27}\right) (3) = \text{no. of faradays}$$

$$\text{no. of faradays} = \frac{x}{9}$$

cost of  $\frac{x}{9}$  faraday = x rupees.

cost of one faraday =  $\frac{x}{x/9} = 9$  rupees

Eq. (Mg) = number of faradays

$\frac{x}{24} \times 2$  = number of faradays

number of faradays =  $\frac{xc}{12}$

cost of  $\frac{xc}{12}$  faradays =  $\frac{xc}{12} \times 9$

=  $\frac{3xc}{4}$  rupees

Q. 24 Eq. (M) =  $\frac{It}{96500}$

$$\frac{1.95}{\text{molar mass of M}} \times 2 = \frac{10 \times 330}{96500}$$

molar mass of M = 114

Eq. (cu) = number of faraday

$$\frac{1.95}{63.5} \times 2 = \frac{Q}{96500}$$

Q = 5926 coulomb

(25)

$$\text{Eq. Ni} = \frac{It}{96500}$$

$$n_{\text{Ni}} \times 2 = \frac{5 \times 20 \times 60}{96500}$$

$$n_{\text{Ni}} = 0.03108 \text{ mol}$$

$$\text{mass of Ni} = 0.03108 \times 58.8$$

$$= 1.827 \text{ gm}$$

$$\approx 1.83 \text{ gm}$$

Q. 26. concentration of  $\text{Ni}(\text{NO}_3)_2$  remain constant in solution

Because we are using Nickel electrodes due to this at anode oxidation of Ni will occur in form of  $\text{Ni}^{+2}$  and this  $\text{Ni}^{+2}$  will deposit in form of Ni on cathode so ultimately concentration of  $\text{Ni}(\text{NO}_3)_2$  will not change.

$$\text{Q. 27. } I_{\text{eq}} = \frac{k \times 1000}{N}$$

$$I_{\text{eq}} = \frac{1}{200} \times 0.88 \times 1000 \\ \cdot 01$$

$$I_{\text{eq}} = 440 \text{ sc.m}^2 \text{ A}^{-1}$$

(28)

$$A_{ep} = \frac{k \times 1000}{M}$$

$$f = \frac{k \times 1000}{0.1}$$

$$k = 4 \times 10^{-4} \Omega \text{ c.m.}^{-1}$$

$$f = \frac{1}{k} = \frac{1}{4 \times 10^{-4}} = \frac{10000}{4} = 2500 \cdot \Omega \text{ c.m.}$$

(29)

$$\text{(i)} \quad k = \frac{1}{R} \cdot \frac{l}{A}$$

$$8 \times 10^{-7} = \frac{1}{R} \cdot \left(\frac{2}{4}\right)$$

$$R = \frac{10^7}{16} = 6.25 \times 10^5 \Omega$$

$$\text{(ii)} \quad I = \frac{V}{R} = \frac{1}{10^7 / 16} = 1.6 \times 10^{-8} \text{ amp.}$$

$$\text{(iii)} \quad k = \frac{1}{800} = 1.25 \times 10^{-3} \Omega \text{ c.m.}$$

$$A_{ep} = \frac{k \times 1000}{N} = \frac{1.25 \times 10^{-3} \times 1000}{0.1} = 125 \Omega \text{ c.m.}$$

31.

$$\lambda_m = \frac{k \times 1000}{M}$$

$$\lambda_m = \frac{\frac{1}{0.005} \times 1000}{\frac{2.08}{0.5} / 208} = 10^7 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\lambda_{ep} \times \eta\text{-factor} = \lambda_m$$

$$\lambda_{ep} \times 2 = 10^7$$

$$\lambda_{ep} = 5 \times 10^6 \text{ Ohm}^{-1} \text{ cm}^2 \text{ esu}^{-1}$$

(32)  $\lambda_m^o (\text{AgBr}) = 140 + 130 - 110$

$$= 160 \text{ S cm}^2 \text{ mol}^{-1}$$

$$k_{\text{solute}} = (8.075 \times 10^7) - (0.75 \times 10^7)$$

$$k_{\text{solute}} = 7.325 \times 10^7$$

$$\lambda_m^o = \frac{k_{\text{solute}} \times 1000}{S}$$

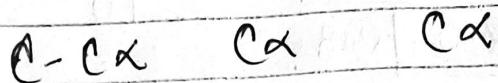
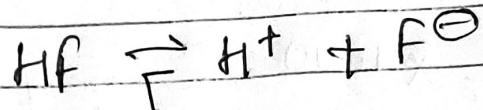
$$160 = \frac{7.325 \times 10^7 \times 10^3}{S}$$

$$S = 4.578 \times 10^6 \frac{\text{mol}}{\text{lit}}$$

$$S = 4.578 \times 10^6 \times (188) \text{ gm/lit}$$

$$S = 8.6 \times 10^4 \text{ gm/lit}$$

Q(33)  $\alpha = \frac{200}{400} = \frac{1}{2} = 0.5$



$$k_a = \frac{c\alpha^2}{1-\alpha} = \frac{2 \times 10^3 \times \gamma_4}{\gamma_2} = 10^3$$

Q.34  $\Lambda_m^\infty(\text{CH}_3\text{COOH}) = \Lambda_m^\infty(\text{CH}_3\text{COONa}) + \Lambda_m^\infty(\text{HCl}) - \Lambda_m^\infty(\text{NaCl})$

$$= 180 + 425 - 125$$

$$= 400 \text{ Sc.m}^2 \text{ mol}^{-1}$$

$$\Lambda_{ep} \times n\text{-factor} = \Lambda_m$$

$$48 \times 1 = \Lambda_m$$

$$\alpha = \frac{48}{400} = 0.12$$

Q.35  $\Lambda_m^\infty(\text{Ba(OH)}_2) = \Lambda_m^\infty(\text{BaCl}_2) + 2\Lambda_m^\infty(\text{NaOH}) - 2\Lambda_m^\infty(\text{NaCl})$

$$= 280 \times 10^{-4} + 2 \times 240 \times 10^{-4} - 2 \times 125 \times 10^{-4}$$

$$= 5.1 \times 10^2 \text{ mho C.m}^2 \text{ mol}^{-1}$$