

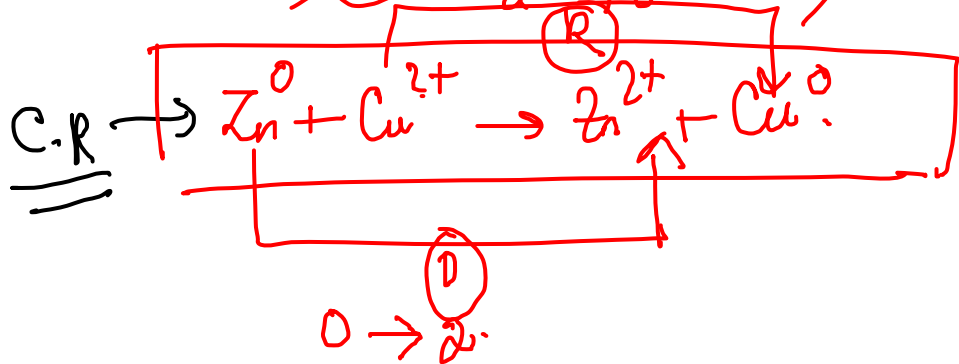
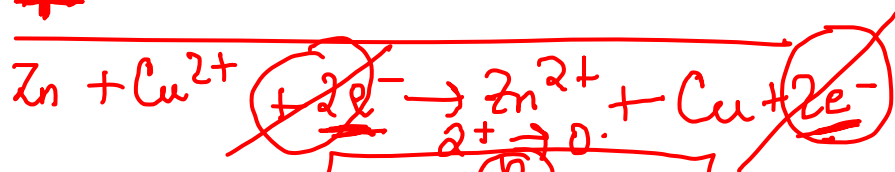
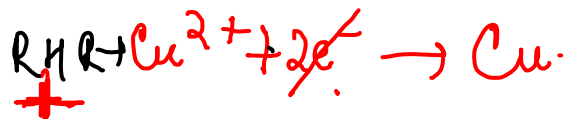
Cell representation :-

Cell rxn .

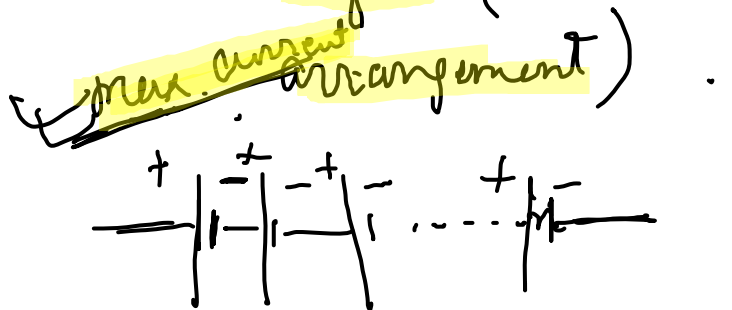
No. of  $e^-$  on LHC rxn and RHC rxn should cancel out.

(L)

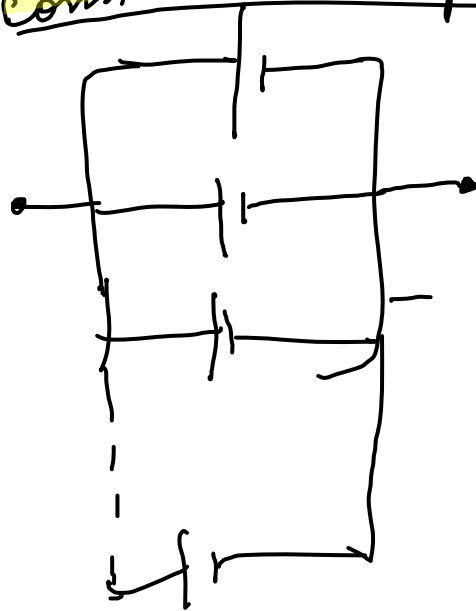
(R)



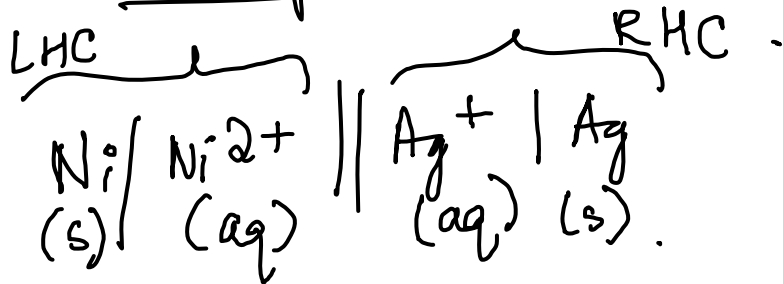
Battery is a combination of cells (in series arrangement).



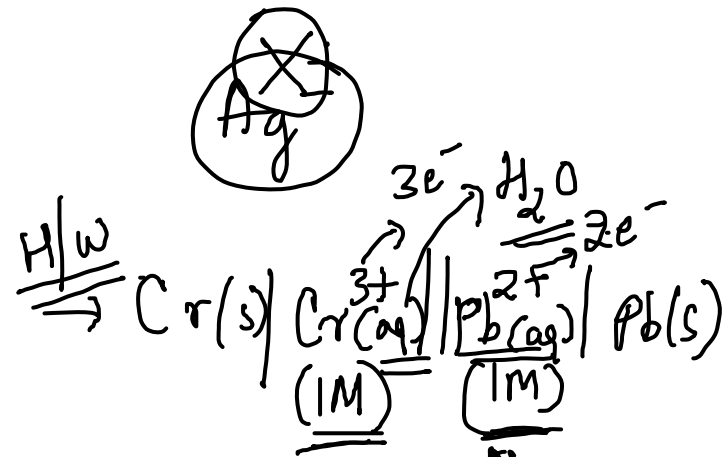
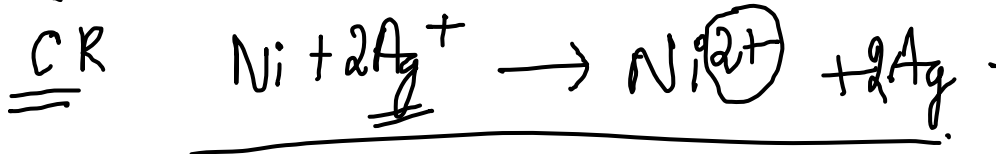
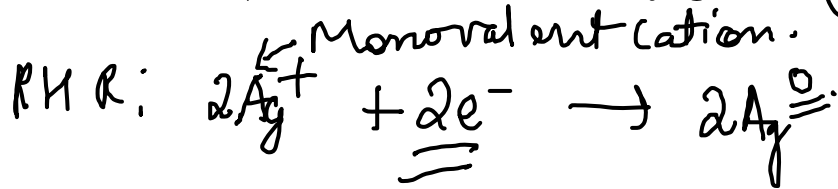
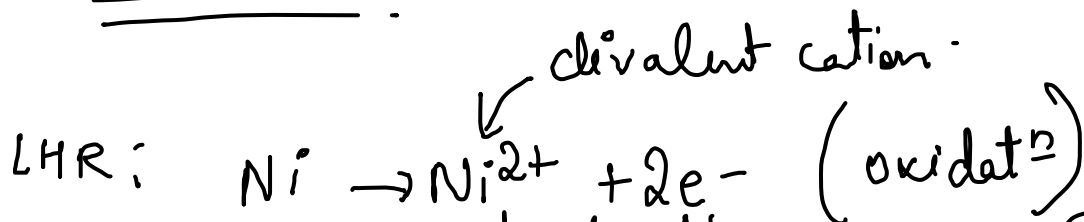
const. electrical potential



Cell representat<sup>n</sup>:



Cell Rk<sup>n</sup>?



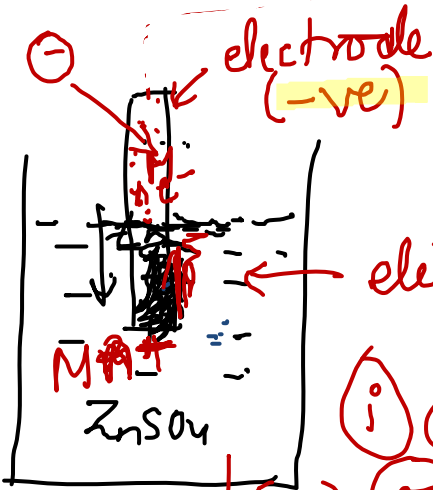
Molarity =  $\frac{\text{moles} \times 1000}{\text{Volume (ml)}}$

\* Cell Rk<sup>n</sup> → ?

LHR  
RHR  
CR

EMF  
Nernst Eq<sup>n</sup>

Electrode Potential :-

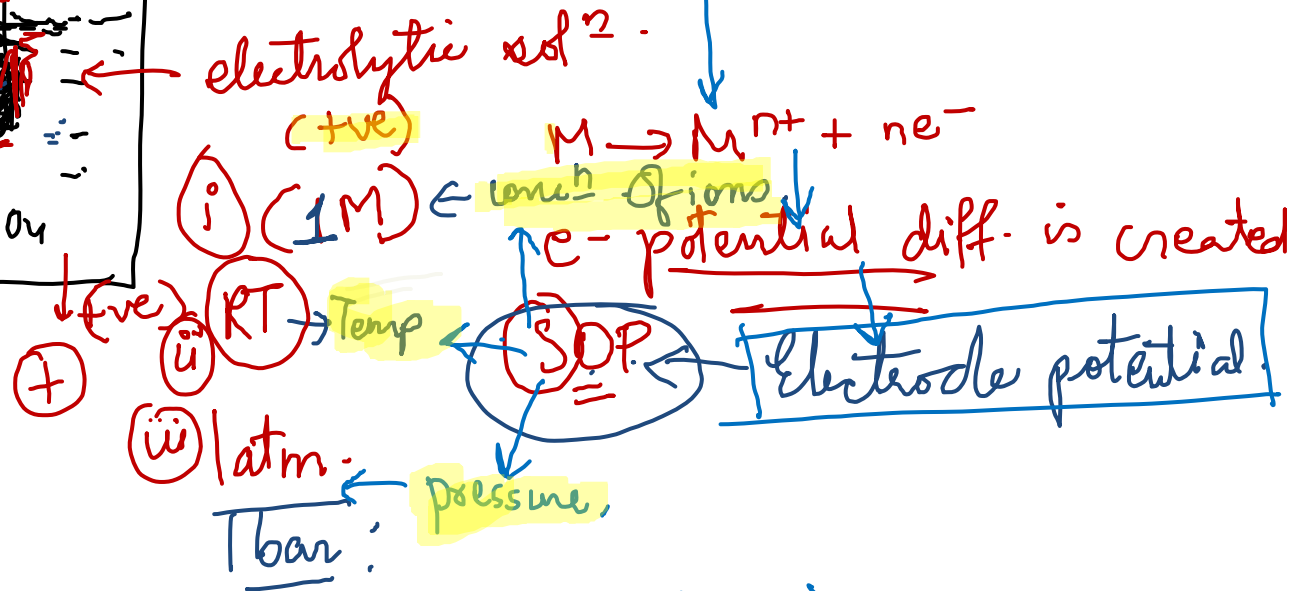


o/dise.  
(into its salt sol<sup>n</sup>)



① Metals have tendency to get oxidized into salt sol<sup>n</sup>

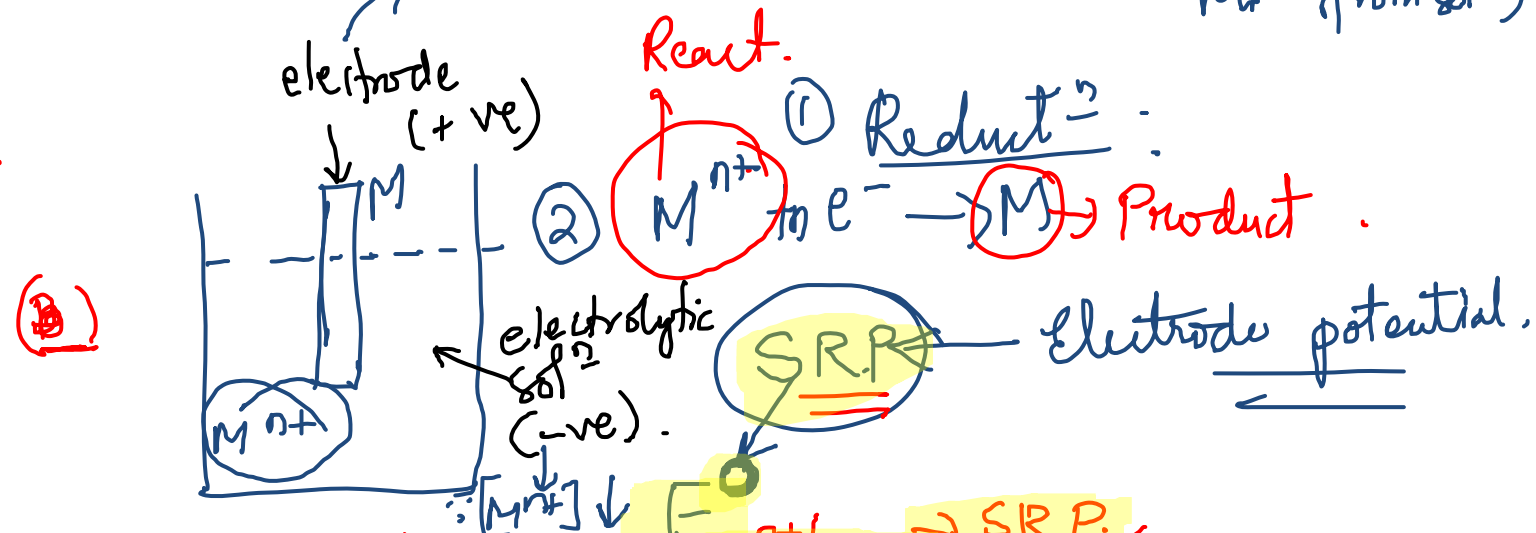
② ∴ Metal from electrode converts to ions ( $M^{n+}$ ) (released in electrolytic solution) in turn releasing  $ne^{-}$  in the sol<sup>n</sup>.



③ Hence → electrode → (-ve) ; sol<sup>n</sup> → (+ve).

~~SRP~~  
~~(+ve)~~

$\therefore e^-$  extracted from rod are used to reduce  $M^{n+}$  from sol<sup>n</sup>



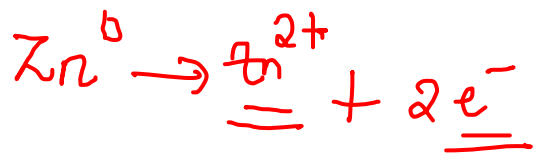
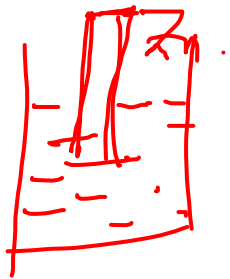
Electrode potential

$(SRP = -SOP)$

(convention)

$E_{M^0/M^{n+}} \rightarrow SOP$

① Some substances have a tendency to get reduced.  
 $\therefore M^{n+}(\text{from sol}^n) + ne^-(\text{from rod}) \rightarrow M(\text{deposited as a precipitate})$

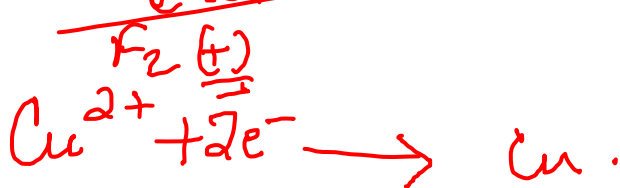


$\text{Li}^{\ominus}$  SRP

$\uparrow$   $\text{Li}^{\oplus}$  (+)

$\text{H} \rightarrow \text{O} \rightarrow \text{O}^{\ominus}$

$\downarrow$   $\text{Li}^{\ominus}$  (-)



Voltmeter (V)

SOP

$$E^{\circ}_{\text{Zn}^0 | \text{Zn}^{2+}} = +0.76 \text{V}$$

SRP ✓

$$E^{\circ}_{\text{Zn}^{2+} | \text{Zn}^0} = -0.76 \text{V}$$

SRP

$$E^{\circ}_{\text{Cu}^{2+} | \text{Cu}} = +0.34 \text{V}$$

SOP

$$E^{\circ}_{\text{Cu} | \text{Cu}^{2+}} = -0.34 \text{V}$$

$$\begin{array}{r} 1.1 \\ 0.76 \\ \hline 0.34 \end{array}$$



EMF of Cell  $\rightarrow$  diff. b/w electrodes of cells.

Electro Motive Force

$$EMF_{cell} = E_{cathode} - E_{anode}$$

$$EMF_{cell}^{\circ} = E_{cathode}^{\circ} - E_{anode}^{\circ}$$

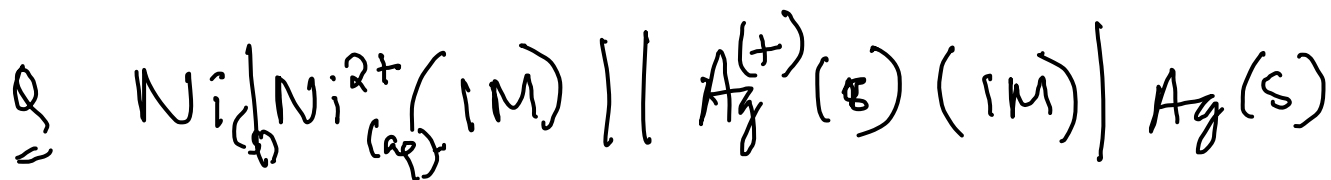
YUAN.

<u>Daniel</u>	<u>Anode</u>	Zn	SRP	-0.76V
	<u>Cathode</u>	Cu	SRP	+0.34V.

$$EMF_{cell}^{\circ} = (0.34V) - (-0.76V)$$
$$= 1.10V \text{ (Ans.)}$$

1.10V.

$$E_{\text{cell}} = \text{EMF}_{\text{cell}} = E^{\circ}_R - E^{\circ}_L$$



$$E^{\circ}_{\text{Ni}^{2+} | \text{Ni}} = -0.25\text{V}$$

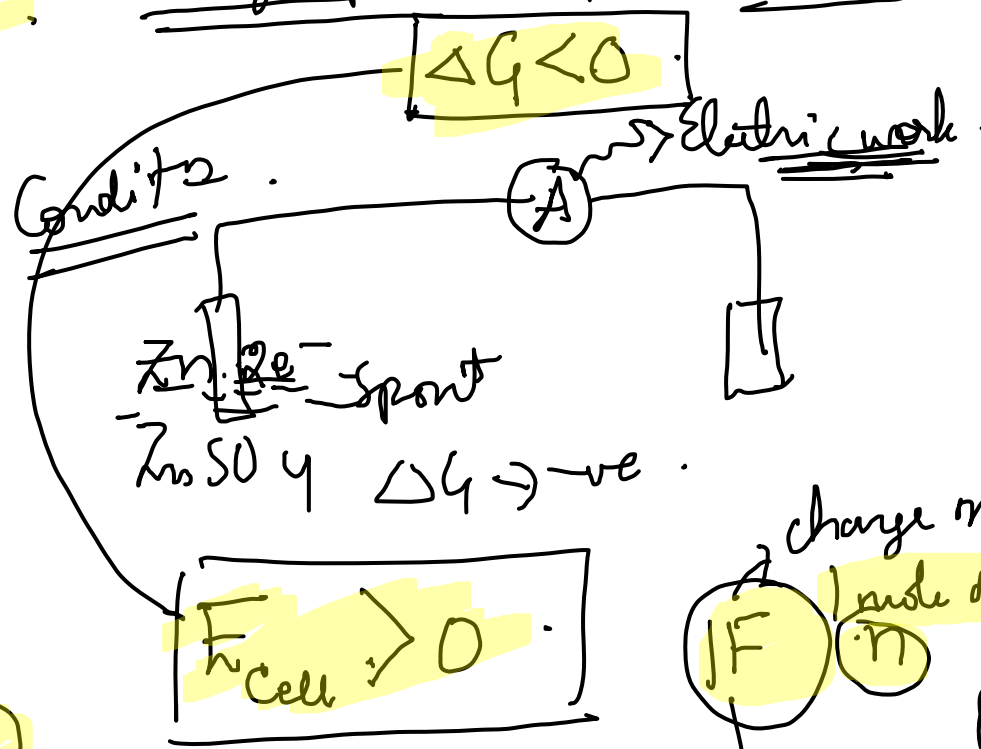
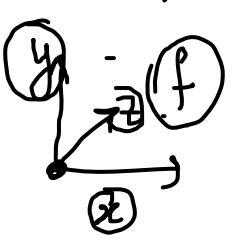
$$E^{\circ}_{\text{cell}} = ?$$

$$E^{\circ}_{\text{Ag}^{+} | \text{Ag}} = +0.80\text{V}$$

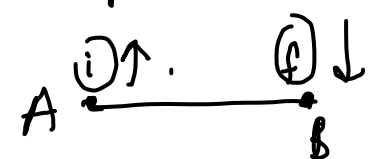
→ BSc 2<sup>nd</sup> yr.

Cell:  
 $\Delta G < 0$   
 $E_{cell} > 0$

Feasibility (spontaneity) of Cell Rx<sup>ns</sup> and Gibbs free Energy



$\Delta G < 0$   
 spont.



$\Delta G < 0$

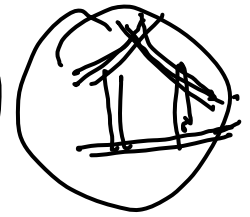
$\Delta V = (w)$   
 2.

$W_{ele} = \Delta V \times q$

charge  $n$   
 1 mole of  $e^-$   
 $n$

96485 C  
 96500 C

rev (ir)

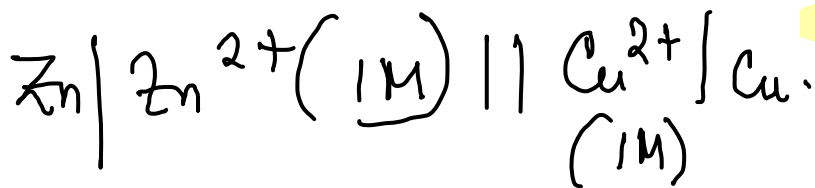


$nF$

$\Delta G = -nFE_{cell}$



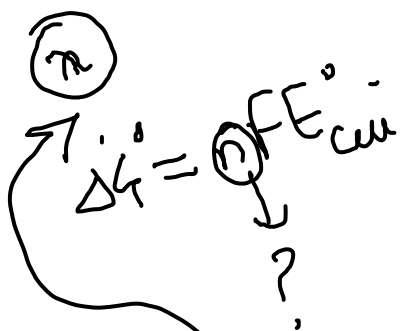
✓ Feasible.



- ① E<sub>cell</sub> > 0
- ② ΔG° < 0

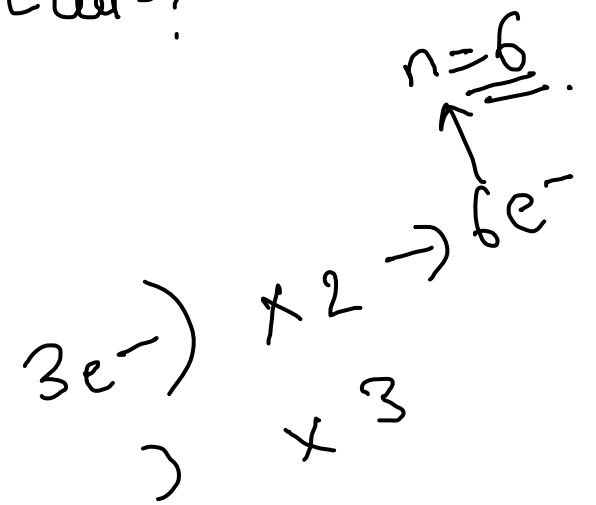
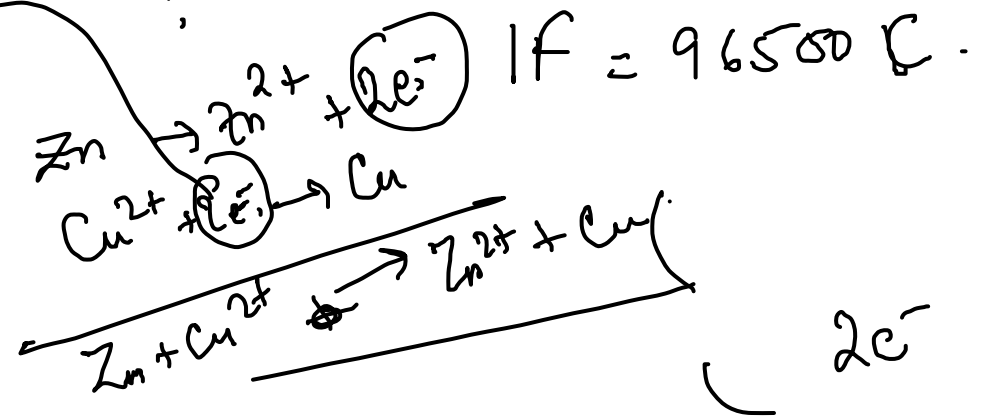
√ ΔG° = ?

√ E<sub>cell</sub> = ?



E<sup>0</sup><sub>Zn<sup>2+</sup>/Zn</sub> = -0.76 V

E<sup>0</sup><sub>Cu<sup>2+</sup>/Cu</sub> = +0.34 V.



Can we stir a  $\text{CuSO}_4$  aq. sol<sup>n</sup> with Zn Rod under  
~~the~~ conditions?

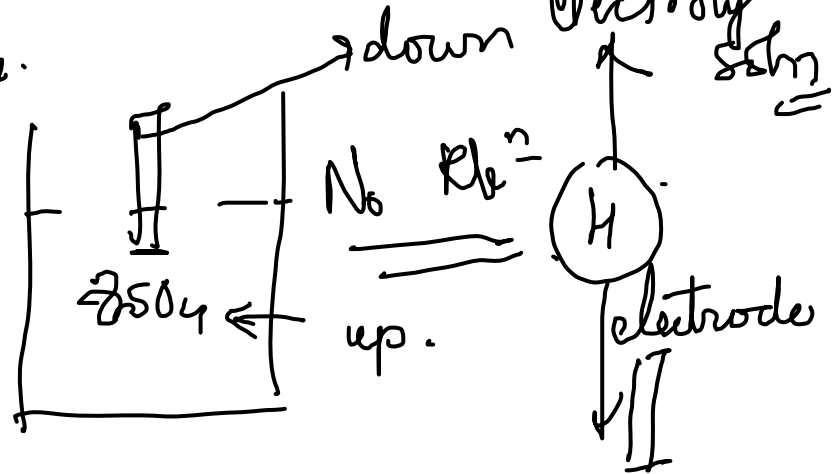
$$E_{\text{cell}}^{\circ} = E_{\text{R}}^{\circ} - E_{\text{L}}^{\circ}$$

$$= +0.34\text{V} - (-0.7\text{V})$$

$$E_{\text{cell}}^{\circ} = +1.10\text{V} > 0$$

$\text{H}_2$  will occur.

Any  
 Cu  
 Au.



$E_{cell} \rightarrow \text{std.}$   
 $E_{cell} = ?$

Nernst Eq<sup>n</sup>

Non std. condit<sup>ns</sup>;  $E_{cell}$ .

8.314 J  
↑  
Universal G. C.

$E_{cell}$   
↓  
EMF  
↓  
non-std. condit<sup>ns</sup>

$$E = E_{cell} - \frac{2.303 RT}{nF} \log \left[ \frac{[R]}{[P]} \right]$$

Annotations:  
-  $(E_R^{\circ} - E_P^{\circ})$  points to  $E_{cell}$   
-  $T \rightarrow (K)$  points to  $T$   
-  $nF$  points to  $nF$   
-  $10 \left[ \frac{R}{P} \right]$  points to the log argument

① Electrode potential at non-std. condit<sup>ns</sup>

Condit<sup>ns</sup> → change conc<sup>n</sup> of R/P  
→ Temp change.

no. of  $e^-$  participating in the rxn.

②  $E_{cell}$  potential at non-std. condit<sup>ns</sup>

Find the RP and OR of  $\text{Fe}^{2+} (0.01\text{M}) | \text{Fe}(s)$  at  $25^\circ\text{C}$   $\rightarrow$  99% 1%

$$E^\circ_{\text{Fe}^{2+} | \text{Fe}} = -0.45\text{V}$$

$$E = E^\circ - \frac{2.303 RT}{nF} \log_{10} \frac{[P]}{[R]}$$

$\begin{matrix} 8.314 \\ 298 \\ \hline 96500 \end{matrix}$

$$E = E^\circ - \frac{0.059}{n} \log_{10} \frac{[P]}{[R]}$$

$$E = E^{\circ} - \frac{0.059}{2} \log_{10} \frac{[1]}{[10^{-2}]}$$

Reduct<sup>n</sup> Potential.  $\text{Fe}^{2+} + 2e^{-} \rightarrow \text{Fe}$ .

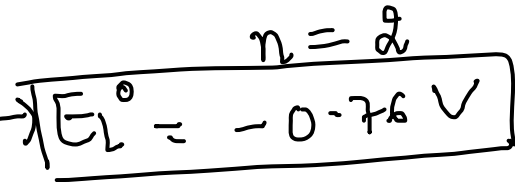
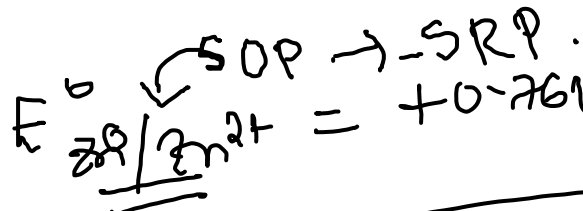
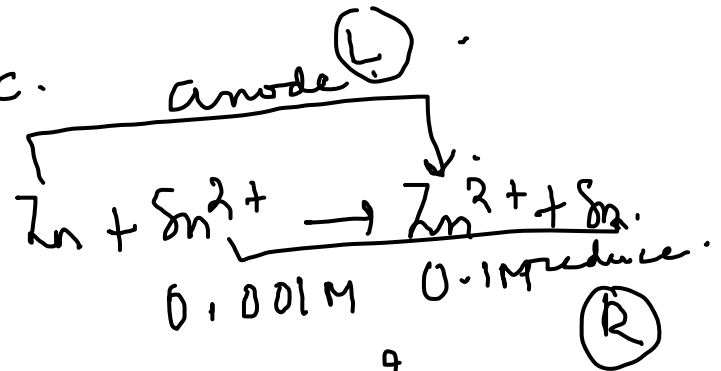
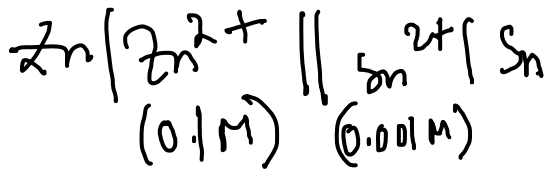
$$\begin{aligned} \text{Ans } E &= -0.45 - \frac{0.059}{2} \times 2 \\ &= -0.45 - 0.059. \end{aligned}$$

$$E_{\text{red}} = \underline{\underline{-0.509 \text{ V}}}$$

$$E_{\text{ox}} = +0.509 \text{ V}.$$



find emf of the cell at 25°C.



0.05g.



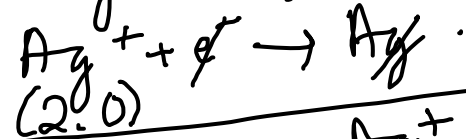
$E^\circ_{\text{cell}} = E_R - E_L$  (red<sup>n</sup> potential)

$$= \{-0.54 - (-0.76)\} \text{V}$$

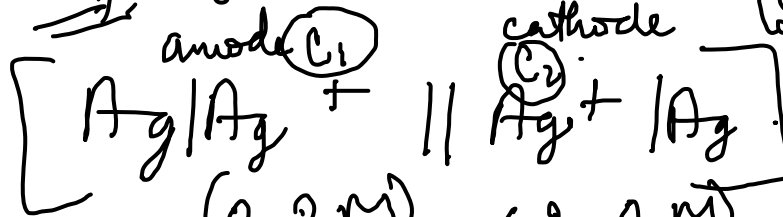
$$= (-0.54 + 0.76) \text{V} = +0.22\text{V}$$

Concentration cell:-

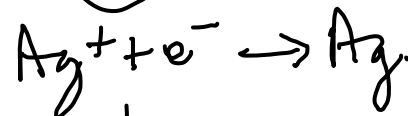
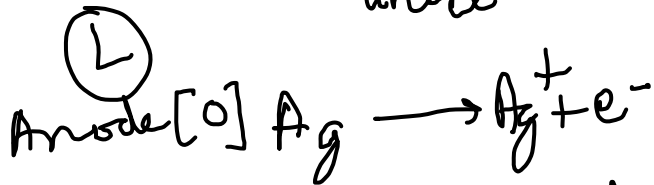
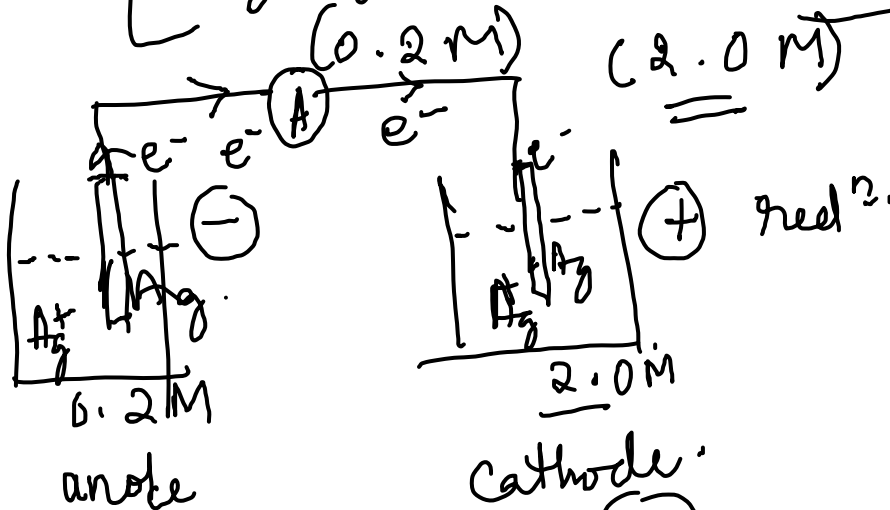
Chemical energy  $\rightarrow$  electrical energy.



Q Find the emf of the conc<sup>n</sup> cell:-



Oxidat<sup>n</sup>



in both anodic and cathodic compartment, but with diff. conc<sup>n</sup> of the involved ions, an emf is generated which can be used to do electrical work.



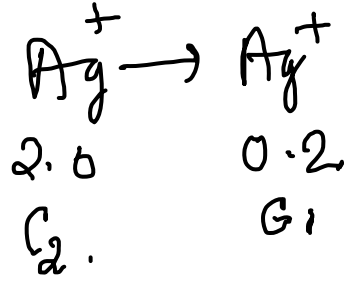
25°C

electrode potential



$E_R = E_L$  (as same metal used)  $\swarrow$  SRP = -SRP

$E_{\text{cell}}^{\circ} = E_R^{\circ} - E_L^{\circ} = 0$



$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.059}{n} \log_{10} \left( \frac{0.2}{2.0} \right)$

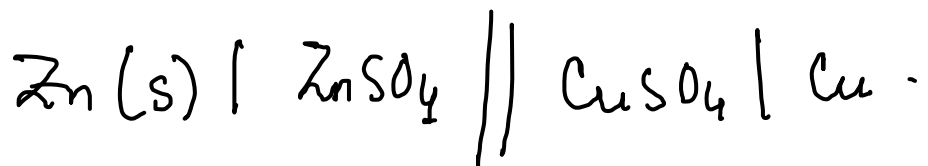
$E_{\text{cell}} = + 0.059 \text{ V}$

$-\frac{0.059}{n} \log_{10} \frac{c_1}{c_2}$

$E_{\text{cell}} = \frac{-0.059}{n} \log_{10} \frac{[P]}{[R]}$

conc<sup>2</sup> cell EMF :-

Q



conc<sup>n</sup> of  $[\text{Zn}^{2+}]$  ions is 10x the conc<sup>n</sup> of  $[\text{Cu}^{2+}]$  ions

$$\Delta G = ?$$

x

10x

$$E^{\circ}_{\text{cell}} = 1.1 \text{ V}$$

- a)  $2.303 RT + 1.1 F$
- b)  $1.1 F$
- c)  $2.303 RT - 2.2 F$
- d)  $-2.2 F$

Equil<sup>m</sup> const. from Nernst eq<sup>n</sup>:-

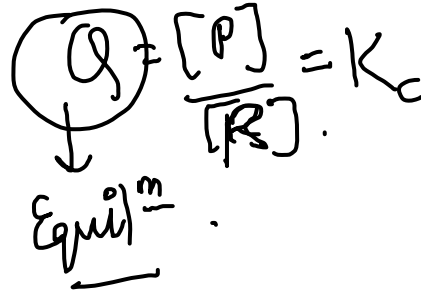
$\Delta G < 0 \rightarrow$  spont.

$\Delta G > 0 \rightarrow$  non-spont.

At equil<sup>m</sup>,

$\Delta G = 0$

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{2.303RT}{nF} \log_{10} Q \quad \Delta G = 0 \rightarrow e_{\text{q}}^{\text{m}}$$



$\Delta G_f < 0$

$\Delta G_R > 0$

$\Delta G = -nFE_{\text{cell}}$

$E_{\text{cell}} = 0$

$E^{\circ}_{\text{cell}} \neq 0$

$Q = \frac{[P]}{[R]} = K_c$

$Q = K_c?$

When  $\Delta G = 0$

$r k^2$  is in equil<sup>m</sup>.

$R_f = R_b$   $\Delta G = 0$

$\Delta G_f > 0$

$\Delta G_r < 0$

$$E_{cell} = E_{cell}^{\circ} - \frac{0.059}{n} \log_{10} \frac{[P]}{[R]} \rightarrow K_c$$

$$0 = E_{cell}^{\circ} - \frac{0.059}{n} \log_{10} K_c \quad \left| \quad \log_{10} K_c = \frac{E_{cell}^{\circ} n F}{2.303 RT} \right.$$

$$E_{cell}^{\circ} = \frac{0.059}{n} \log_{10} K_c$$

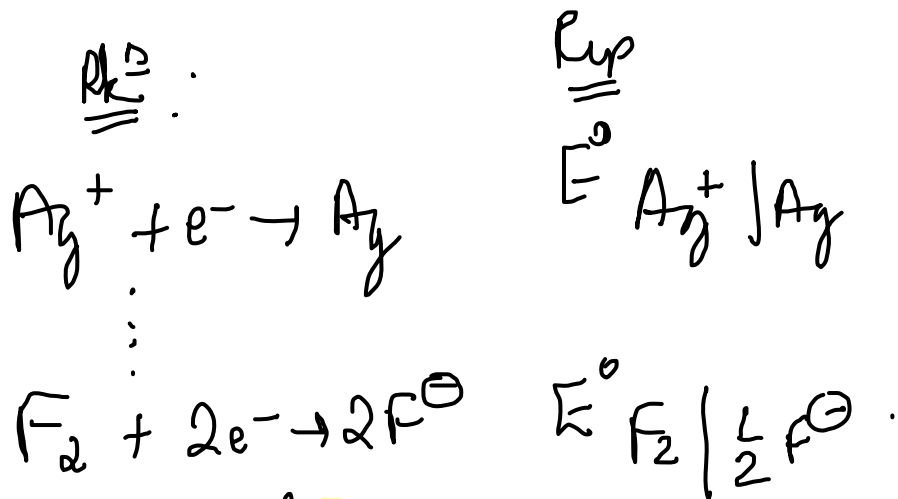
$$\log_{10} K_c = \frac{n E_{cell}^{\circ}}{0.059} \quad \text{at } 25^{\circ}C$$

default  $\rightarrow 8.314 \text{ J/mol}\cdot\text{K}$   
 gaseous  $\rightarrow 0.082 \text{ atm}\cdot\text{mol}\cdot\text{K}$

# Metal Activity Series.

⊛ Elements are arranged in order of ↑ std. red<sup>2</sup> potential.  
(SRP).

Red <sup>2</sup>	best R.A because they get oxidized themselves ↓ (e <sup>-</sup> lose)	Representat <sup>2</sup>	SRP.
Li <sup>+</sup> + e <sup>-</sup> → Li <sup>0</sup>		E <sup>0</sup> Li <sup>+</sup> /Li <sup>0</sup>	-3.05V.
⊛ Zn <sup>2+</sup> + 2e <sup>-</sup> → Zn		E <sup>0</sup> Zn <sup>2+</sup> /Zn.	-0.76V.
Fe <sup>2+</sup> + 2e <sup>-</sup> → Fe		E <sup>0</sup> Fe <sup>2+</sup> /Fe	-0.45V.
2H <sup>+</sup> + 2e <sup>-</sup> → H <sub>2</sub>		E <sup>0</sup> H <sup>+</sup> /½ H <sub>2</sub> .	0 ← Ref.
Cu <sup>2+</sup> + 2e <sup>-</sup> → Cu		E <sup>0</sup> Cu <sup>2+</sup> /Cu	+0.34V

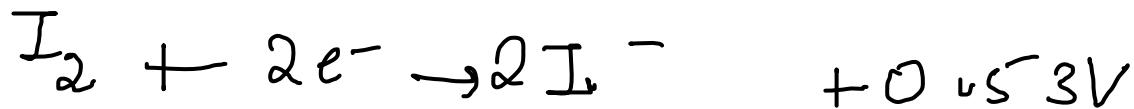
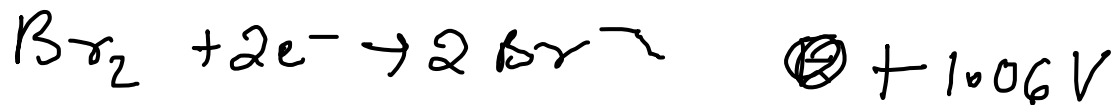
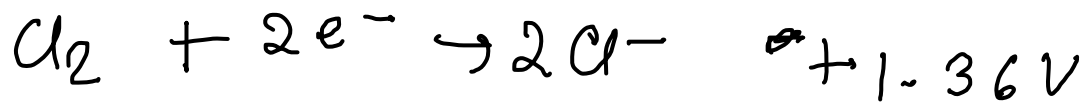


SRP  
 +0.80V  
 ...  
 +2.87V

best 0.A  
 because they  
 get reduced  
 themselves.  
 ↓  
 (gain  $e^-$ )

↓ OA  
 +

Q SRP given:-



Strongest ~~OA~~ and strongest RA ~~a)  $F_2/I_2$~~  ~~b)  $F_2/I^-$~~

~~a)  $F_2/I^-$~~  [O]

b)  $Br_2/Cl^-$

c)  $Cl_2/Br^-$

d)  $Cl_2/I_2$ .

(SRP)  
Std. Electrode Potential

X  $\rightarrow$  -1.2V

Y  $\rightarrow$  +0.5V

Z  $\rightarrow$  -3.0V - reducing agent

The order of Reducing power of these metals?

a)  $Y > Z > X$

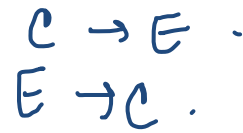
b)  $Y > X > Z$

~~c)  $Z > X > Y$~~

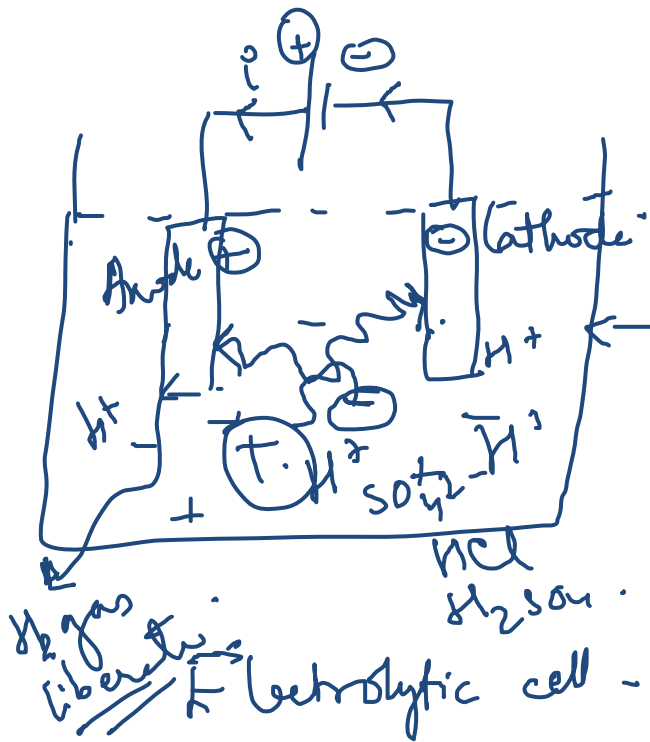
d)  $X > Y > Z$



# Electrochemistry :-



Faraday's laws of Electrolysis :- 2 laws.



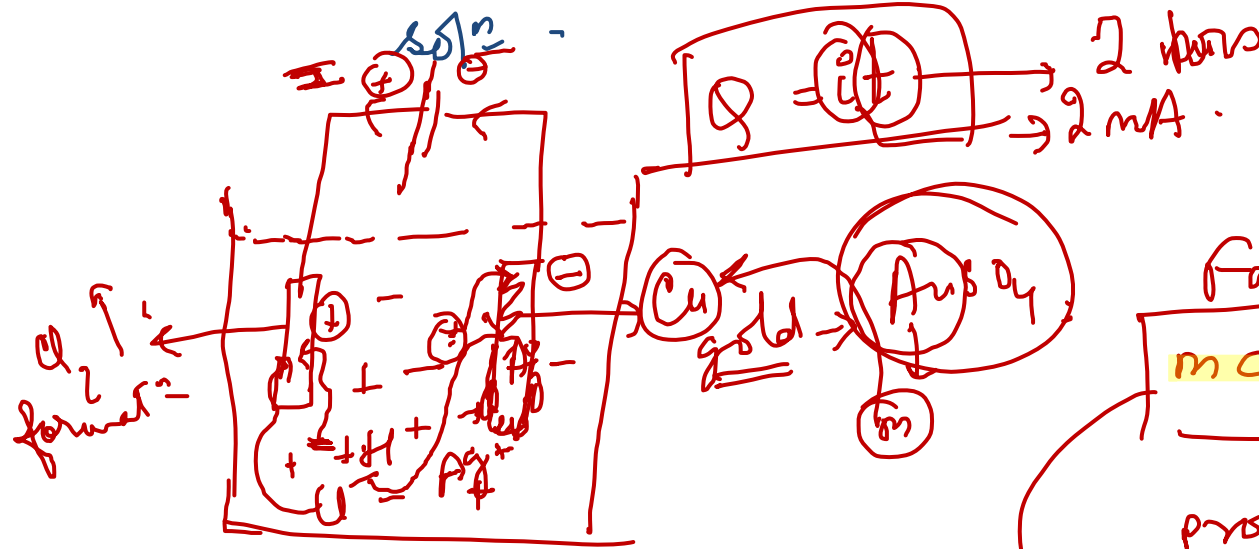
electrolytic  
 $SO_4^{2-} \rightarrow$  ions  $\rightarrow$  electric current.

ions migrate to electrodes  
 to finish off their

charge  $\rightarrow$  "discharge the  
 electrodes".

$Q = it$

1st - The mass of substance deposited or the mass of gas liberated at a particular electrode is directly  $\propto$  to amt. of charge passing through the



Faraday's 1st Law of Electrolysis

$m \propto Q$

proportionality relation.

$m = ZQ$  const

$Z =$  Equivalent wt.

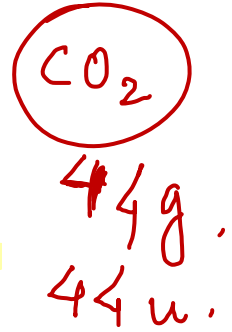
Faraday's const

$\rightarrow 96500 C$

Expt



Equivalent wt. =  $\frac{\text{Molar mass}}{\text{charge transfer on ion}}$



Q amt. Cu deposited when 5 A of current is used for 1 hr.  
in an electrolytic sol<sup>n</sup> of  $\text{CuSO}_4$

At. wt. of Cu = 63.5 g  
 $F = 96500 \text{ C}$

$m \propto Q$   
 $m = zQ$   
 $m = zit$

$Q = it$  - electrochemical equivalent

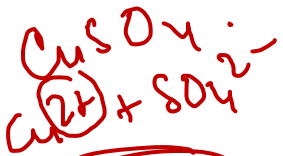
$z = \frac{\text{Mol. mass}}{F \times \text{charge transfer on ion}}$  Eq. wt

$$m_{Cu} = z it$$

$$z = \frac{\text{Eq. wt}}{\text{Faraday's const.}}$$

$$m = \left[ \frac{63.5}{2} \times \frac{1}{F} \right] \times 5 \times 3600$$

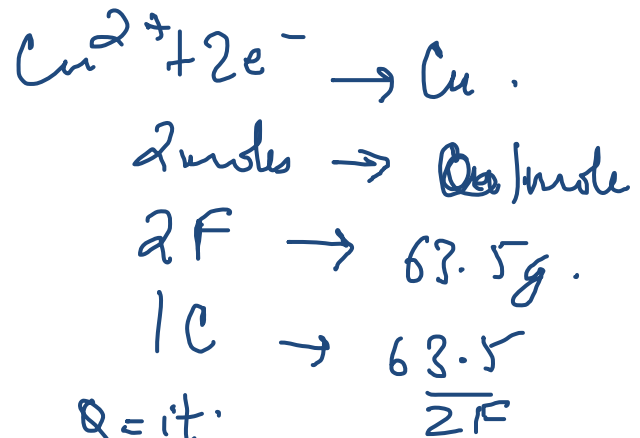
$\downarrow$  Eq. wt.       $\downarrow$  z



-ve electrode

$$z = \frac{\text{Molar mass } 63.5}{2 \times 96500}$$

- a) 4.2g
- b) 8g
- c) 6.6g
- d) 8.2g



$$Q = it$$

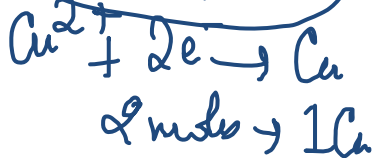
$$5 \times 60 \times 60 \rightarrow \frac{63.5}{2F} \times 5 \times 60 \times 60$$

295  
JEE

Two F of Electricity is passed through a sol<sup>n</sup> of  $\text{CuSO}_4$ . The mass of Cu deposited at cathode is :- (At. wt. 63.5g)

- a) 6g
- b) 63.5g
- c) 2g
- d) 12.7g

Unitary method



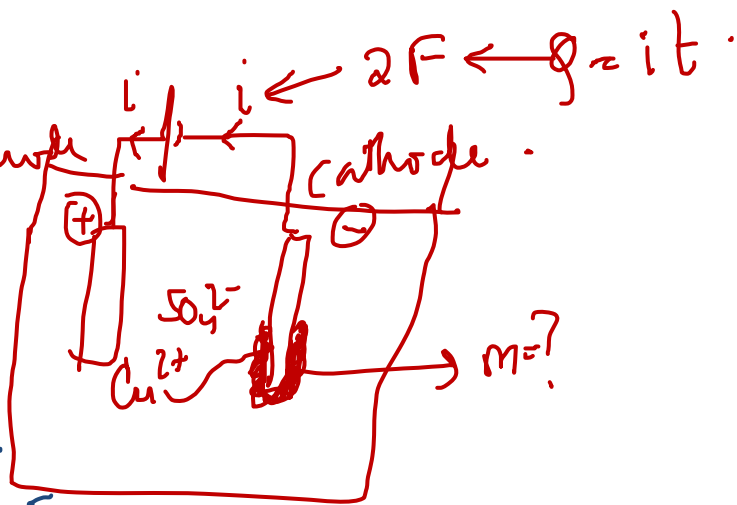
$$2F \rightarrow 63.5 \text{ g}$$

$$m = \frac{2}{2} \times 2F$$

$$= \frac{63.5}{2F} \times 2F$$

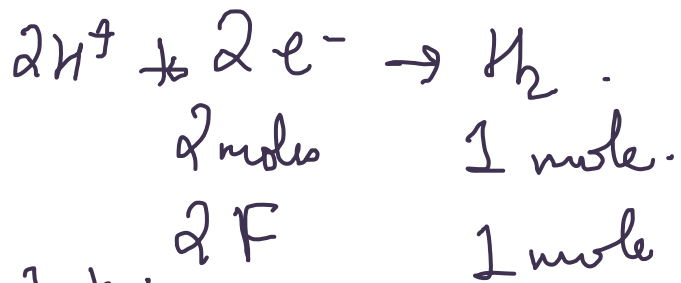
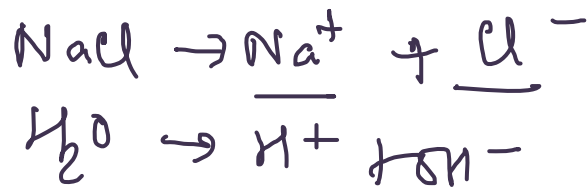
$$= 63.5 \text{ g}$$

(Ans)



Q) Electrolysis of dilute aq. NaCl sol<sup>n</sup> was carried out by passing 10mA current. The time req. to liberate 0.01 mole of H<sub>2</sub> gas at one of the electrodes is?

- a)  $6.4 \times 10^4 \text{ s}$
- b)  $9.15 \times 10^4 \text{ s}$
- c)  $19.3 \times 10^4 \text{ s}$
- d)  $10^4 \text{ s}$ .



$Q = it$

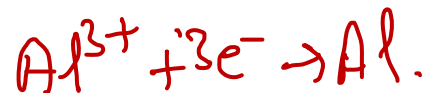
$$0.02 \times 96500 = 10 \times 10^{-3} \times t$$

$0.02 \text{ F}$	$0.01 \text{ mole}$
↓	
charge.	

Q A current of 2A <sup>input</sup> is passed for 1hr through a sol<sup>n</sup> of  $AlCl_3$  (molten) has a current efficiency of 50%. Find the amt. of Al deposited at cathode.

max

At. mass 27g  
1F = 96500C.



- a) 1.33g
- b) 0.66g
- c) 0.33g
- d) 1.66g

$$i_{\text{output}} = 1A.$$

$$= \frac{2 \times 1 \times 3600}{3 \times 96500}$$

$$= 0.33g$$

Q A charge of  $1F$  deposits

- a) 1 mole of subs.
- b) 1 g of subs.
- c) 1 gm equivalent of subs.
- d) 1 atom of subs.

$$m = \frac{E}{F} \times \text{charge} \rightarrow 1F$$

$$m = \frac{E}{F}$$

↓  
eq. wt.



Electrochemical equivalent :-

(Z)

$$m = Z Q.$$

$$Q = 1 F.$$

$$m = Z$$

When 1 F charge is passed, the amt. of substance deposited is called  
ECE. (Z).

## Faraday's 2<sup>nd</sup> Law of electrolysis.

If same amt. of ~~substance~~ electric charge is passed through diff. electrolytes, then amt. of substance deposited (or gas liberated) is  $\propto$  its eq. wt.

$$m_{Zn} = Z_1 Q_1$$

$$m_{Cu} = Z_2 Q_2$$

$$Q_1 = Q_2$$

$$\frac{m_{Zn}}{m_{Cu}} = \frac{E_{Zn}}{E_{Cu}}$$

$$m_{Zn} = \frac{E_{Zn}}{f} \times Q$$

$$m_{Cu} = \frac{E_{Cu}}{f} \times Q$$

$$m \propto \text{Eq. wt.}$$

$$\left[ \frac{m_1}{m_2} = \frac{E_1}{E_2} \right]$$

$i \rightarrow$  same.

$Q_1 \rightarrow$  same.

$m \propto \text{Eq. wt.}$

$$\frac{m_1}{m_2} = \frac{E_1 \rightarrow \text{eq. wt. sub. 1}}{E_2 \rightarrow \text{eq. wt. sub. 2}}$$

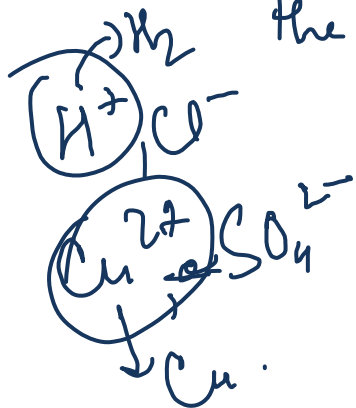
$$E = \frac{M \cdot n}{x}$$

↓  
Charge transfer.

F2LOE  
H/W

Q. Same electric charge is passed through an aq. sol<sup>n</sup> of HCl and CuSO<sub>4</sub>. If 12g H<sub>2</sub> is liberated, find

the mass of Cu deposited :-



a) 402g

b) 381g

c) 860g

d) 369g.



Metallic Conductor

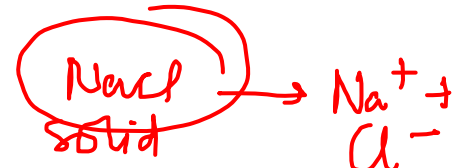
① free  $e^-$  conduct<sup>n</sup>.

② ~~no~~ chemical decomposition of substance.

③ Resistance is due to collision with kernels.

v.s.

Electrolytic conductor



cond<sup>n</sup>  
 $c^{+2}$

① flow of ions.

② ~~chemical decomposition~~

③ Resistance due to multiple interactions.

(i) Solute-solute interact<sup>n</sup>

$\text{Na}^+ / \text{Na}^+$  rep.

$\text{Na}^+ / \text{Cl}^-$  attract<sup>n</sup>.

(ii)  $\text{Cl}^- / \text{Cl}^-$  repulsion.

(iii)  $\text{NaCl} / \text{H}_2\text{O} \rightarrow$  solute solvent interact<sup>n</sup>  
solvent-solvent interact<sup>n</sup>?

$$\frac{1}{\rho} \propto \frac{1}{A^{n-1}}$$

Examp<sup>t</sup>:  
(4)

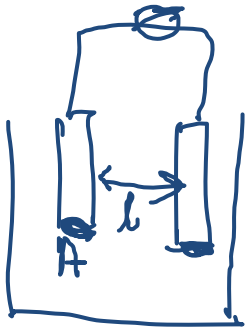
Resistancy  $\uparrow$  on  $\uparrow$   
temp.

Resistance  $\downarrow$  with  $\uparrow$   
temp.  
(due to weakening  
of interact<sup>n</sup>s).

Remember the units and formulae:-

Resistance ( $\Omega$ )

Conductance, Siemens or  $\Omega^{-1}$   
 $\rightarrow \frac{1}{R}$



$\frac{l}{A} \rightarrow$  const.

Specific resist.  $\rho = \frac{RA}{l}$

$\rho \propto \frac{A}{l}$  unit  $\Omega m.$

specific conductance or conductivity ( $\sigma$ )

$\sigma = \frac{1}{\rho}$

$K = \frac{l}{RA}$

unit  $\sigma = S m^{-1}$  or  $(\Omega^{-1} m^{-1})$

$K = \frac{\text{conductance}}{\text{cell const}}$

about cell const.  
 $K$  easily calc.  
 or  $K$  fixing of dimension of experimental and convenience  
 $\frac{l}{A} \rightarrow$  unit  $cm^{-1}$

# Equivalent conductance ( $\Lambda_e$ )

Conductance due to all the ions present in that vol. of electrolyte that contains "1g eq. of ions".

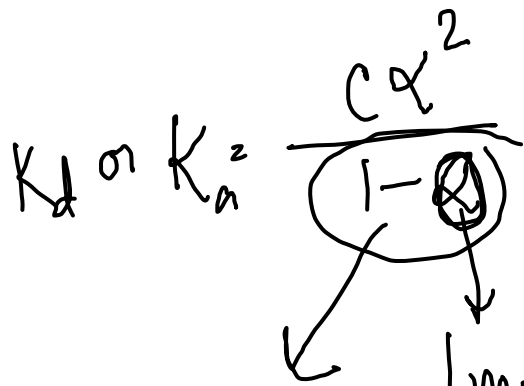
$\Lambda_m = \chi \Lambda_e$   
 $\chi = \frac{\Lambda_m}{\Lambda_m^0}$   
 degree of dissociation

$\Lambda_e \text{ wt.} = \frac{\text{Molar mass}}{\text{charge on each ion}}$   
 $\Lambda_e \text{ wt.} = \frac{\text{Molar mass}}{\chi \cdot \text{factor}}$

$\text{Na}^+ \text{Cl}^-$   
 /  
 anionic = charge on anion  
 cationic = charge on cation  
 neutral salt = charge on cation







1 mole theke koto ta  
and dissociate korlo-

1 mole  $\text{CH}_3\text{COOH} \rightarrow \alpha$   
 weak acid -  
 very very small  
 $\approx 0.001$

$$K_a = C\alpha^2$$

acid dissociat<sup>n</sup>  
const.

$$1 - 0.001$$

$$0.999 \approx 1$$

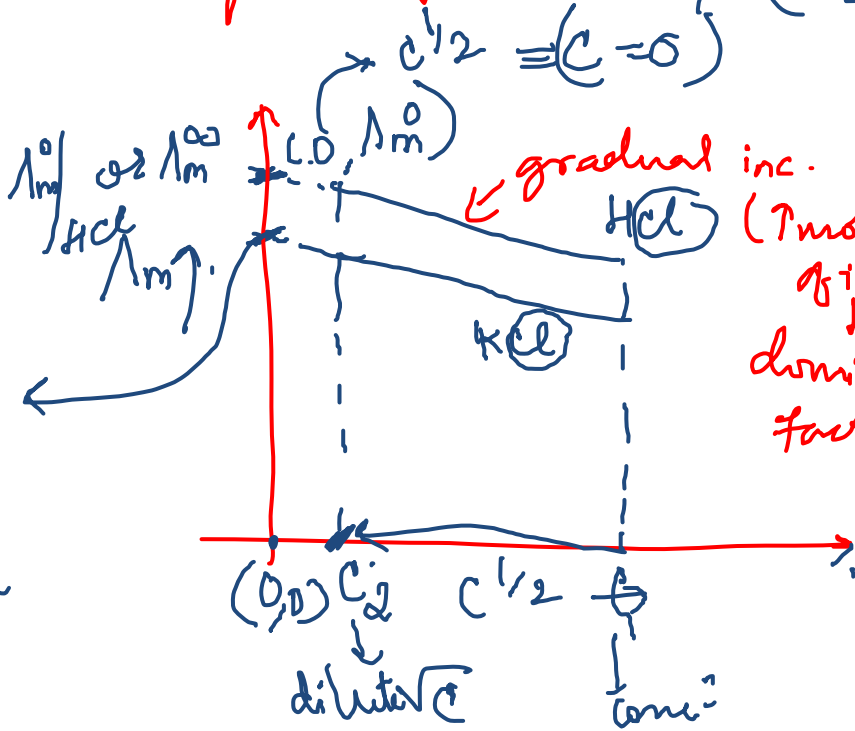
$$\alpha = \sqrt{\frac{K_a}{C}}$$

conc<sup>n</sup> of electrolyte

$$\alpha = \frac{\Lambda_m}{\Lambda_m^0} = \frac{\Lambda_m}{\Lambda_m^\infty}$$

Case I - Strong electrolytes

(infinite dilut<sup>n</sup>)



gradual inc. HCl is stronger acid (Probability of ions dominating factor)

$H^+$  ← ionic mobility ( $\mu$ )  
↓  
max

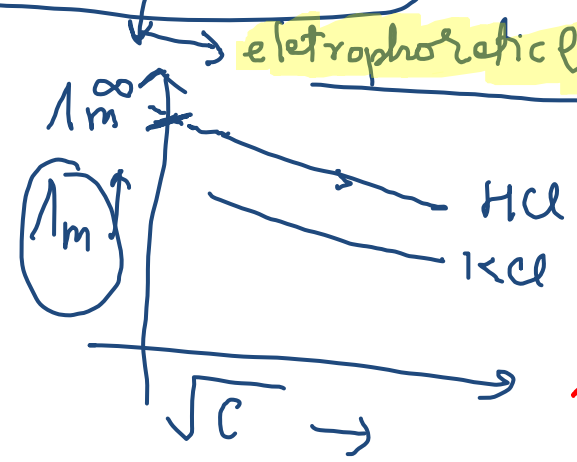
$$\boxed{\mu_{H^+} > \mu_{K^+}}$$

$$\Lambda_m^\infty |_{HCl} > \Lambda_m^\infty |_{KCl}$$

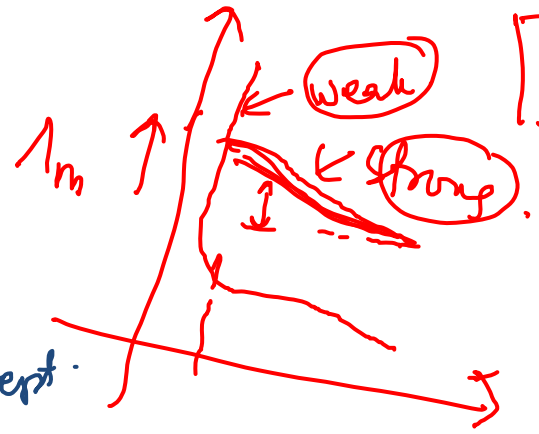
Note: - limiting molar conductivity values for any electrolyte is directly  $\propto$  to its components ionic mobility.

$\Lambda_m = \Lambda_m^\infty - (60.2 + 0.229 \Lambda_m^\infty) \sqrt{c}$  (limit HCl 0.1 L sol<sup>n</sup>)  $\rightarrow C_1 = \frac{1}{0.1} M$ .

asymmetry effect is 50% dissociat<sup>n</sup>?



$C_1 = 10 M$   
 $C_2 \rightarrow 1 L$  99.5% of the electrolyte  $\rightarrow$  diss  $\rightarrow 1$ .



$C_2 \rightarrow \frac{1}{1} = 1 M$

0.5% dominant factor  
 stability  $T_{in}$  ions  
 ions no.  $\uparrow$

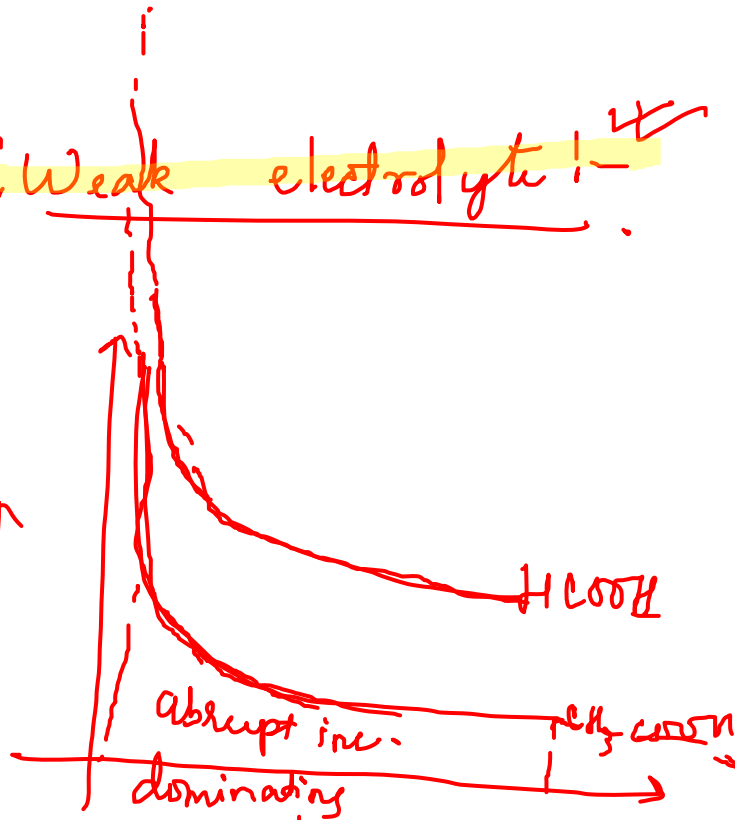
$y = mx + c \rightarrow y$  intercept.

$\Lambda_m = \frac{1}{b} \sqrt{c} + \Lambda_m^\infty$

Debye - Huckel - Onsager eq<sup>n</sup>  
 const  $\rightarrow$  slope  $\rightarrow$  viscosity surface tension.  
 only valid strong electrolyte for

Case II: Weak electrolyte! -

$\Lambda_m$



acidity  
 Formic acid  $\left\{ \begin{array}{l} \text{acetic acid} \\ \text{CH}_3\text{COOH} \end{array} \right.$   
 $\text{HCOOH}$

Note: -

$\Lambda_m^\infty$  can't be calculated

graphically by extrapolating the curve to touch the y axis.

factor  $C^{1/2} \rightarrow$   
 $\uparrow$  ions flourished.  
 $\neq$

$\Lambda_m^\infty$

$C \uparrow$ ,  $\text{dil}^{\frac{1}{2}} \downarrow$ ,  
 10M, vol  $\downarrow$ ,  
 5%  $\rightarrow$  % dissociation  
 95%  $\alpha$  is very small  
 left undiss.  
 $C \downarrow$ ,  $\text{dil}^{\frac{1}{2}} \uparrow$ , vol  $\uparrow$ .  
 1M, (95%) of the undiss.

ions flourish  $\rightarrow$  dissociate  
 ionic mobility  $\uparrow$

Problem statement :-  $\Lambda_m^\infty$  for strong electrolyte can be derived graphically but not for weak electrolyte. Why and how is the problem resolved?

Sol :-

→ Why?

→ "Kohlrausch's Law of Independent Migration of ions"

valid for both strong electrolytes and weak electrolytes

$\Lambda_m^\infty$  → Strong  
↓ Weak.

$$\rightarrow (\Lambda_m^\infty)_{\text{electrolyte}} = (\Lambda_m^\infty)_{\text{cation}} + (\Lambda_m^\infty)_{\text{anion}}$$

$$\rightarrow (\Lambda_m^\ominus)_{\text{electrolyte}} = (\Lambda_m^\ominus)_{\text{cation}} + (\Lambda_m^\ominus)_{\text{anion}}$$

$$\begin{array}{c} (\Lambda_m^\infty)_{\text{NaCl}} \\ \downarrow \\ \text{Cap. m} \end{array} = (\Lambda_m^\infty)_{\text{Na}^+} + (\Lambda_m^\ominus)_{\text{Cl}^-}$$

total ionic conductivity  
of total electrolyte

ionic conductivity of  
individual sp.

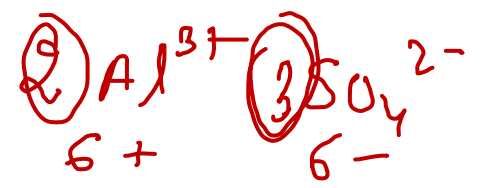
$\nu_{+} \rightarrow$   $\downarrow$  moles of   
 (no.) of cations.

$\nu_{-} \rightarrow$  (no.) of anions.   
 $\downarrow$  moles of

$\lambda_{m}^{\infty}$  Na<sup>+</sup>

$$\lambda_{m}^{\infty} \text{ electrolyte} = \nu_{+} \times (\lambda_{m}^{\infty})_{\text{cation}} + \nu_{-} (\lambda_{m}^{\infty})_{\text{anion}}$$

$$\lambda_{m}^{\infty} \text{Al}_2(\text{SO}_4)_3 = 2 \times (\lambda_{m}^{\infty})_{\text{Al}^{3+}} + 3 \left[ (\lambda_{m}^{\infty})_{\text{SO}_4^{2-}} \right]$$





$$\left(\Lambda_m^\infty\right)_{\text{NaCl}} = 125 \frac{\text{S cm}^2 \text{ mol}^{-1}}{\text{SI unit}}$$

$$\left(\Lambda_m^\infty\right)_{\text{CH}_3\text{COONa}} = 30 \frac{\text{S cm}^2}{\text{mol}}$$

$$\left(\Lambda_m^\infty\right)_{\text{HCl}} = 420 \text{ S cm}^2 \text{ mol}^{-1} \quad (2 + 3 - 1)$$

$$\left(\Lambda_m^\infty\right)_{\text{CH}_3\text{COOH}} = ?$$

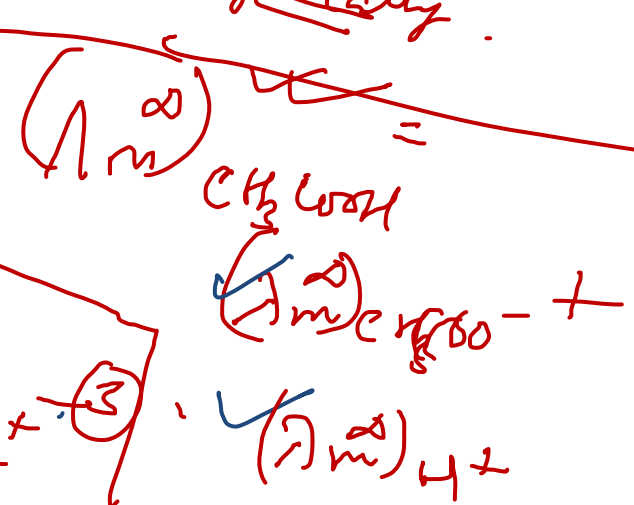
weak.

$$\left(\Lambda_m^\infty\right)_{\text{NaCl}} = \left(\Lambda_m^\infty\right)_{\text{Na}^+} + \left(\Lambda_m^\infty\right)_{\text{Cl}^-} \quad \text{--- (1)}$$

$$\left(\Lambda_m^\infty\right)_{\text{HCl}} = \left(\Lambda_m^\infty\right)_{\text{H}^+} + \left(\Lambda_m^\infty\right)_{\text{Cl}^-} \quad \text{--- (2)}$$

$$\left(\Lambda_m^\infty\right)_{\text{CH}_3\text{COONa}} = \left(\Lambda_m^\infty\right)_{\text{CH}_3\text{COO}^-} + \left(\Lambda_m^\infty\right)_{\text{Na}^+} \quad \text{--- (3)}$$

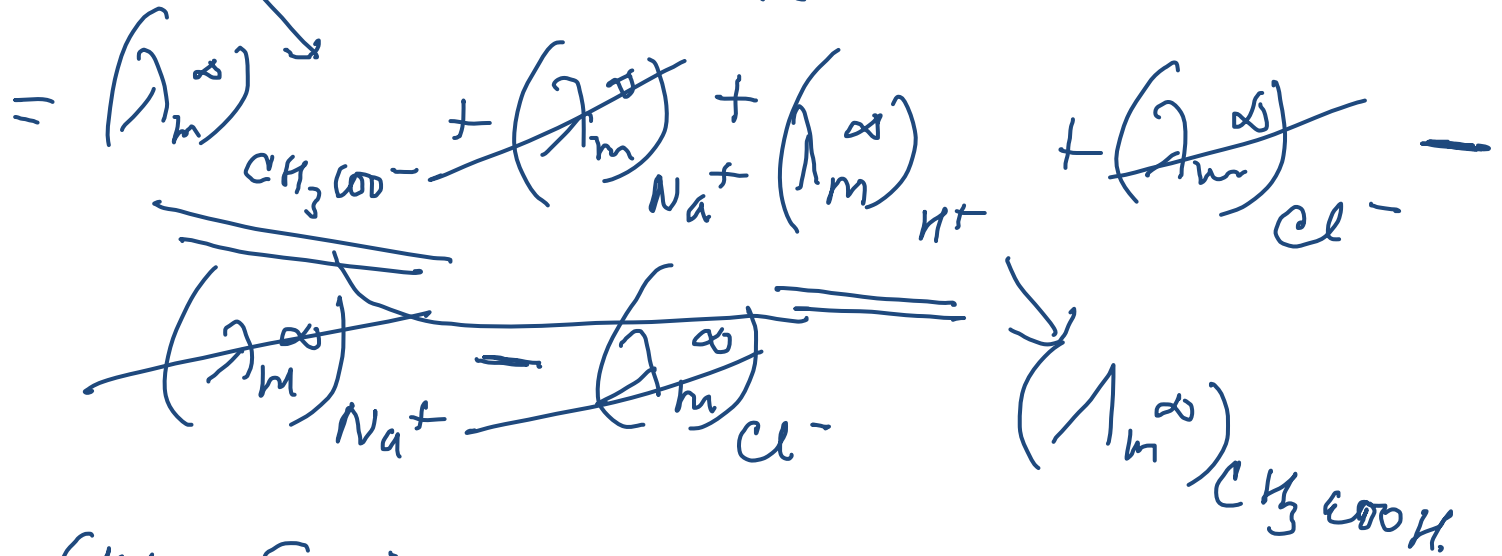
graphically.



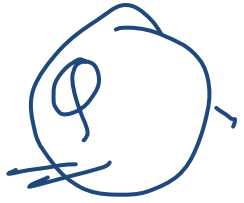


$$3 + 2 - (1) \rightarrow \text{NaCl}$$

$$(305) + 420 - 125$$



$$= \underline{\underline{600 \text{ Scm}^2 \text{ mol}^{-1}}}$$



$$\left(\Lambda_m^\infty\right)_{\text{Ba}(\text{OH})_2} = 500 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\left(\Lambda_m^\infty\right)_{\text{BaCl}_2} = 300 \text{ " " " "}$$

$$\left(\Lambda_m^\infty\right)_{\text{NH}_4\text{Cl}} = 120 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\left(\Lambda_m^\infty\right)_{\text{NH}_4\text{OH}} = ?$$