Faraday I^{st} law :-

$$W \propto Q$$

$$W = Z \cdot Q$$

Z → electrochemical equivalent $= \frac{E}{96500}$

Q → Charge in C.

$$M = \frac{n}{V_{(L)}}$$

$$N = M \cdot V.f.$$

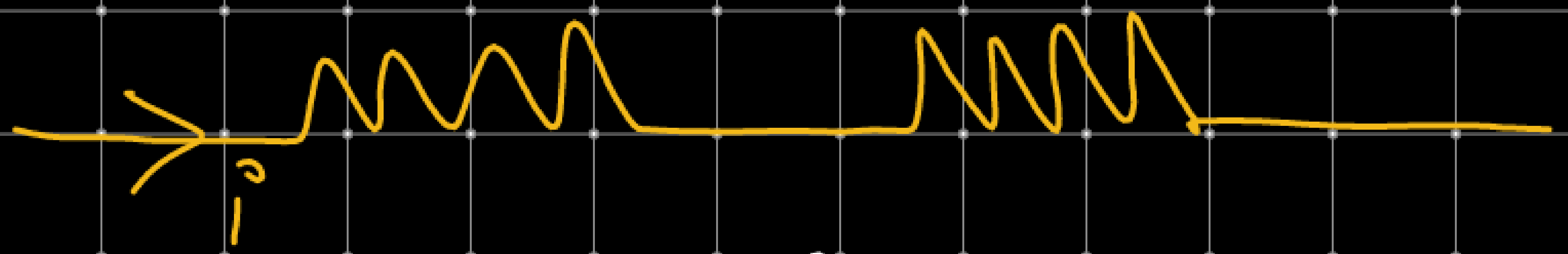
$$W = \frac{E}{96500} \cdot Q$$

$$\frac{W}{E} = \frac{W}{M.w} \times V.f. = mol \cdot V.f = M \cdot V_{(L)} \cdot V.f = N \cdot V_{(L)} = \frac{Q}{96500}$$

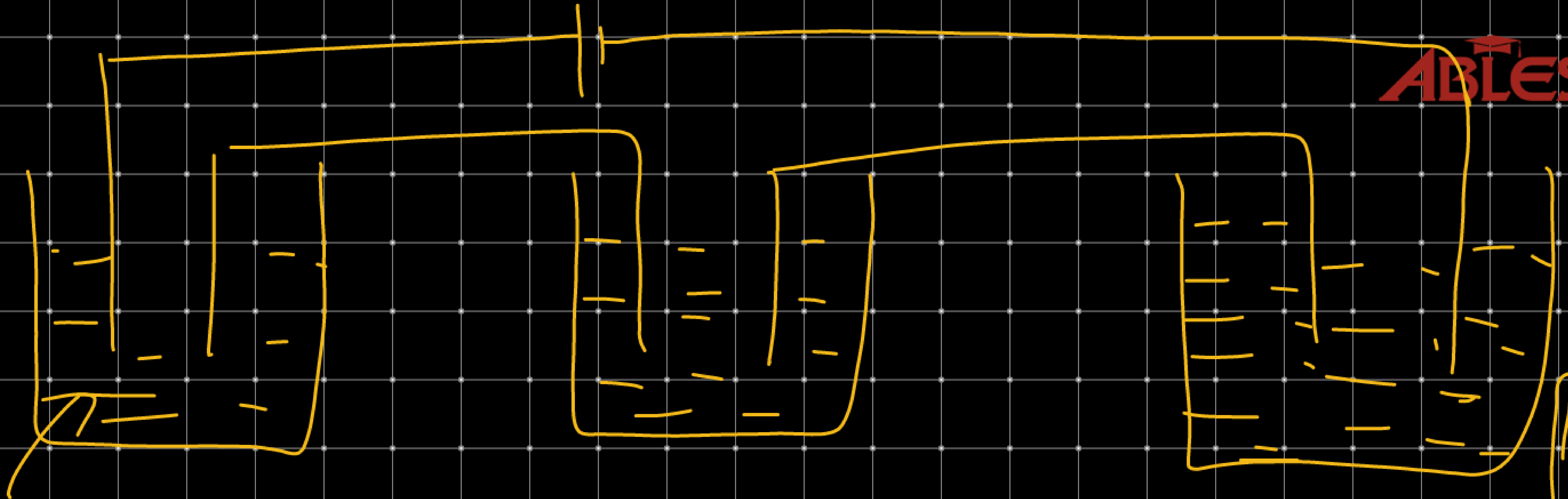
Faraday IIrd law :

$$\frac{W}{E} = \frac{Q}{96500} \rightarrow \text{Constant [Same charge pass.]}$$

$$\Rightarrow W = k \cdot E \Rightarrow \boxed{W \propto E}$$



When same amount of current is passed through different electrolytic solution connected in series, then amount of substance is directly proportional to their equivalent weight.



$$W_1 \propto E_1$$

$$W_1 = kE_1$$

$$k = \frac{W_1}{E_1}$$

$CuSO_{4(aq)}$	$FeCl_{2(aq)}$	$AgNO_{3(aq)}$
W_1 (Cu)	W_2 (Fe)	W_3 (Ag)
E_1	E_2	E_3

$$\frac{W_1}{E_1} = \frac{W_2}{E_2} = \frac{W_3}{E_3}$$

Q.1. 2.5F Charge is passed through Aq. Soln of H_2SO_4. Cal. Amount of Substance deposited/liberated at anode and Cathode.

Sol.

$$H_2SO_{4(aq)} + H_2O$$

$$H^+ + SO_4^{2-} \quad H^+ + OH^-$$

Anode(+ve) Cathode(−ve)

$$H_2O \longrightarrow \frac{1}{2}O_{2(g)} + 2H^+ + 2e^- \qquad e^- + H^+ \longrightarrow \frac{1}{2}H_{2(g)}$$

at anode :- $Q = 2.5\,F = 2.5 \times 96500\,C$

$$\frac{W_{(O_2)}}{E} = \frac{Q}{96500} \Rightarrow W_{O_2} = \frac{2.5 \times 96500}{96500} \times 8$$

$$\boxed{W_{(O_2)} = 20\,g.}$$

at Cathode :- $W_{H_2} = \frac{Q}{96500} \times E_{(H)}$

$$= \frac{2.5 \times 96500}{96500} \times 1 \Rightarrow \boxed{W_H = 2.5\,g.}$$

Q.2. Cal. amount of Cu deposited at Cathode when a current of 2 amp is passed in aqous $CuSO_4$ for 30 min.

(M.W. of Cu = 63.5)

Sol. $W = \frac{E}{96500} \cdot I \cdot t$

$Cu \rightarrow Cu^{2+}$

$E = \frac{M.W}{V.F} = \frac{63.5}{2}$

$W = \frac{63.5}{2 \times 96500} \times 2 \times 30 \times 60$

$W = 1.18\ g$

Q. 3. A current of 9.65 amp is passed in 1 L aq. solution of NaCl for 10 sec. Cal. pH of soln after electrolysis.

Sol.

$$NaCl + H_2O$$

$$Na^+ + Cl^- \qquad H^+ + OH^-$$

Anode (+ve): $Cl_2(g)$

Cathode (−ve): $H_2(g)$

⇒ after elec. soln is basic

NaOH soln.

$$[OH^-] = N$$

$$N\,V_{(L)} = \frac{I \cdot t}{96500} \Rightarrow N \times 1 = \frac{965 \times 10}{96500 \times 100}$$

$$N = 10^{-3} = [OH^-]$$

$$\Rightarrow \boxed{pOH = 3} \Rightarrow pH = 14 - pOH$$

$$\boxed{pH = 11}$$

Q. 4. On passing electric current through $H_2SO_{4(aq)}$ soln, the ratio of masses of substance liberated at cathode & anode.

(a) 1 : 8 (b) 8 : 1 (c) 1 : 16 (d) 16 : 1

Sol

$H^+ + SO_4^{2-} + H^+ + OH^-$

$(W_2) \rightarrow$ Anode (+ve) $O_{2(g)}$

Cathode (−ve) $\rightarrow H_{2(g)}$ (W_1)

$$\frac{w_1}{w_2} = \frac{E_{H_2}}{E_{O_2}} \Rightarrow \boxed{\frac{w_1}{w_2} = \frac{1}{8}}$$

Q. 4F Charge is passed through aq. soln of $CuSO_4$, $AgNO_3$ & $FeCl_3$. Cal. ratio -

(1) g-equivalent of Cu, Ag & Fe deposited.

(2) mole of Cu, Fe & Ag

(3) mass of Fe, Ag & Cu.

(1) $\left(\frac{W}{E}\right)_{Cu} = \frac{Q}{96500} \Rightarrow \left(\frac{W}{E}\right)_{Cu} = \frac{4 \times \cancel{96500}}{\cancel{96500}}$

$\left(\frac{W}{E}\right)_{Cu} = 4 = \left(\frac{W}{E}\right)_{Ag} = \left(\frac{W}{E}\right)_{Fe}$

$\Rightarrow \left(\frac{W}{E}\right)_{Cu} : \left(\frac{W}{E}\right)_{Ag} : \left(\frac{W}{E}\right)_{(Fe)}$

$4 : 4 : 4$

$\Rightarrow 1 : 1 : 1$

$\left\{ \frac{W}{E} = \text{mol} \times \text{v.f} \right\}$

(ii) $\left(\frac{W}{E}\right)_{Cu} = \text{mole} \times \text{V.f} = 4$

$\Rightarrow \text{mol} \times 2 = 4$

$\Rightarrow (\text{mole})_{Cu} = \frac{4}{2}$

$\Rightarrow (\text{mol} \times \text{V.f})_{\overset{+}{Ag}|NO_3} = \text{mole} \times 1 = 4$

$(\text{mole})_{Ag} = 4$

$\Rightarrow (\text{mole} \times \text{V.f})_{\overset{+3}{Fe}|Cl_3} = 4 \Rightarrow \text{mol} \times 3 = 4$

$(\text{mole})_{Fe} = 4/3$

$$(mole)_{Cu} : (mole)_{Fe} : (mole)_{Ag}$$

$$\frac{4}{2} : \frac{4}{3} : \frac{4}{1}$$

$$\Rightarrow \frac{1}{2}\times 6 : \frac{1}{3}\times 6 : \frac{1}{1}\times 6$$

$$\Rightarrow 3 : 2 : 6$$

(3) $\left(\frac{w}{E}\right)_{Fe} = 4 \Rightarrow w = 4 \times E$

$$w_{Fe} = \frac{4 \times 56}{3}$$

$$\left(\frac{w}{E}\right)_{Ag} = 4 \Rightarrow (w)_{Ag} = 4 \times E \Rightarrow (w)_{Ag} = 4 \times 108$$

$$\left(\frac{w}{E}\right)_{Cu} = 4 \Rightarrow w_{Cu} = 4 \times E \Rightarrow w_{Cu} = \frac{4 \times 63.5}{2}$$

Ques. How many Faraday are required in following Chemical Change.

(i) Oxidation of 1 mole of FeO to Fe_2O_3

Sol. $2FeO + H_2O \longrightarrow Fe_2O_3 + 2H^+ + 2e^-$

$\Rightarrow 2F$

(ii) — " — H_2O to O_2

Sol

I^{st}

$$H_2O \longrightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$$

2F

II^{nd}

$$2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$$

4F

1 mole $H_2O \longrightarrow$ 2F

(3) $MnO_4^- \longrightarrow Mn^{2+}$

(4) $Cr_2O_7^{2-} \longrightarrow Cr^{+3}$

(5) $C_6H_5-NO_2 \longrightarrow C_6H_5-NH_2$