Current Electricity

Electric current → rate of flow of charge.

Av electric current - time interval

$$I_{avg.} = \frac{\Delta q}{\Delta t} \quad \text{ampere (A)}$$

$$\left(1A = \frac{1C}{1\,sec} \right)$$

) Instantaneous electric current (current at any instant) $I = \lim_{\Delta t \to 0} \left(\frac{\Delta q}{\Delta t} \right)$

$$\boxed{I = \frac{dq}{dt}}$$

$$dq = I\,dt$$

$I = f(t)$ variable current.

total charge $q = \int_0^t I.dt$

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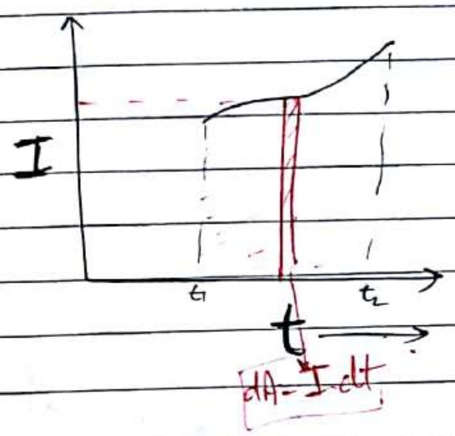
Avg current

$$I_{av} = \frac{q}{t}$$

$$\frac{\int_0^t I.dt}{t}$$

if graph

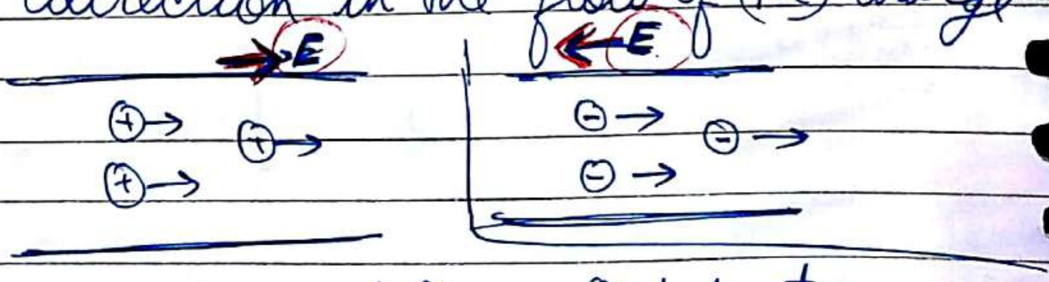


total area under curve

$$A = \int_{t_1}^{t_2} I.dt = \text{total charge.}$$

Dir of current

It is the direction in the flow of (+ve) charge



no current in the right direction

1) Conductor — free e^-

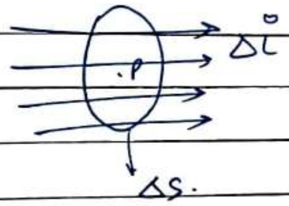
2) Insulator — dont conduct electricity (no free e^-)

3) Semi conductor**

Current density ($\vec{J}$)

It is a vector quantity.

- current per unit normal area



average current density

$$J_{(avg)} = \frac{\Delta i}{\Delta s}$$

current density at point P

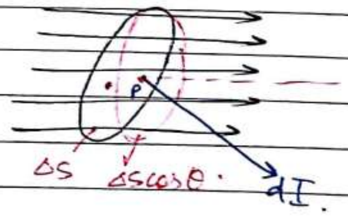
$$J = \lim_{\Delta s \to 0}\left(\frac{\Delta i}{\Delta s}\right)$$

$$\boxed{J = \frac{di}{ds}}$$

dir of current density in the dir of current

$$\text{Unit} = \frac{A}{m^2}$$

(8)



$$I = \frac{\Delta i}{\Delta S \cos\theta}$$

current density ρ

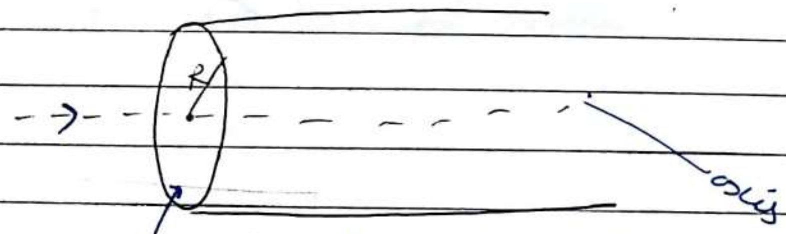
$$J = \frac{di}{ds\cos\theta}$$

$$di = J.ds\cos\theta$$

$$di = \vec{J}.\vec{ds}$$

<u>net current</u>

$$I = \int \vec{J}.\vec{ds}$$



current density $= J_0$ const

Current $I = J_0.(\pi R^2)$

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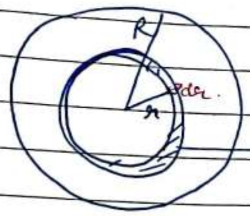
(B) current density $J = J_0 r$ ← (dis from axis)



elemental area
$ds' = 2\pi r\,dr$.

$$dI = (J_0 r)(2\pi r\,dr)$$

$$= 2\pi J_0 r^2 dr.$$

net current

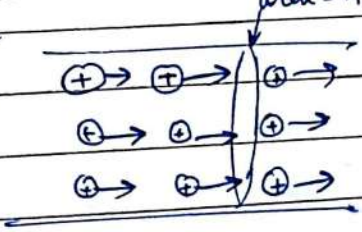
$$I = \int_0^R dI.$$

$$= \int_0^R 2\pi r^2 dr\,J_0 = \frac{2\pi J_0 R^3}{3}$$

Relation b/w current (I) and velocity of charged particle.

area = A.

Beam of charged particle

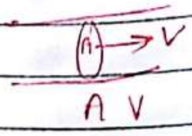


q → charge of each particle.
A → area of cross section
v → velo of particle.
n → no of charged particles per unit volume.

Current (I) = charge flow through cross section in 1 sec.

$$\boxed{I = A\,V\,n\,q}$$

Area Velo number charge of each particle



$\cancel{A}$ $J = \frac{I}{A} = \cancel{A}Vnq$

[current density]

Ques → Current flowing in a conductor depends on time 't' as $I = 2t+3$ A per sec

1) find charge flow through any cross-section from $t=0$ to $t=4$ sec
2) Avg current in $t=0$ to $t=4$ sec

total charge

1) $q = \int_0^4 I\,dt = \int_0^4 (2t+3)\,dt$

$$\boxed{q = 28\ C}$$

2) avg current $= \frac{q}{t} = \frac{28}{4} = 7A$

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Q – Calculate no of free e^- per unit Volume in a metallic conductor of density $10^4\ kg/m^3$ and mass no = 100 (molecular mass) each other atom contribute 1 e free electron.

$\frac{I}{A} = 10^4 A$. $10^4 A = A v n q$

$M = 100$ $d = 10^4 kg/m^3$

$M_w \longrightarrow N_A$.

$m \longrightarrow \frac{N_A}{M_w} \times m$.
(Vol = V)

= no of atom per unit Vol

$= \frac{N_a\, m}{M_w\, V}$

$\frac{d.N_a}{M_w}$

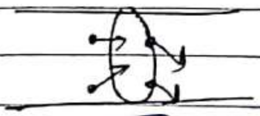
no of e^- per unit vol $= \frac{6.02\times10^{23}\times10^4}{100\times10^{-3}(kg)}$.

$\int_0^4 (2t+3)\,dt$ $\int_0^4 2t+3$ t^2+3t
16+12
28
$\left(\frac{2t^2}{2}+3t\right)_0^4$ 16+12 28

gravitation → Discuss EX-I Comp part I & II. | & Current – Read

movement of free e^- inside conductor

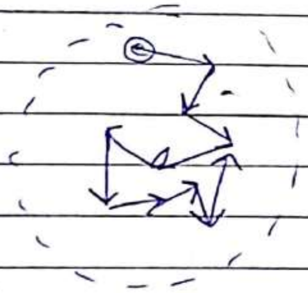
motion of e^- $\longrightarrow$ random



$\boxed{I=0}$

$$\boxed{\langle \vec{V} \rangle = 0} \qquad \langle \vec{V} \rangle = \frac{\vec{V}_1 + \vec{V}_2 + \vec{V}_3 + \dots}{N} = 0$$

(V_d)



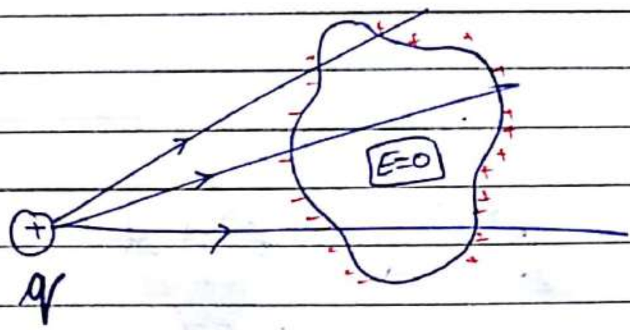
e^- का Movement

due to thermal energy

$$\frac{3}{2}KT = \frac{1}{2}mv^2$$

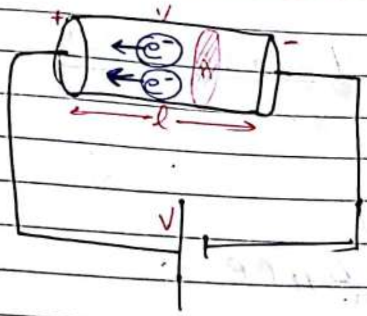
at room temp.

$$\boxed{V = 10^6 \, m/sec}$$



$q = 10^6 \times 1.6 \times 10^{-19} \times n$

$5 = 10^6 \times 1.6 \times 10^{-19} \cdot n \qquad \frac{5 \times 10^{19-6}}{10^6 \times 1.6} = \frac{10^{13} \times 5}{16}$



$\vec{E} = \frac{V}{l}$ ← potential diff maintained

Electric field

$(V_d = 10^{-3}\ m/sec)$

(V_d) drift velo → avg velo of e^-

$$\boxed{I = A\, V_d\, n\, e}$$

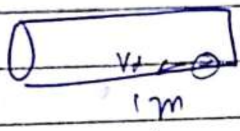
(area) (drift) ← charge of $1e^-$

current flowing in conductor

no of e^- per unit volume

Q- find approx dist travelled by e^- in an time interval in which its ~~distance~~ displacement is 1m. along the wire

$V = 10^6\ m/sec$



$t = \frac{l}{V_d}$

$t = \frac{1}{10^{-3}} = 10^3$ sec.

distance = vt

$10^6 \times 10^3 = 10^9$ m Ans

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Relation b/w I & V in a conductor

Electric current — Potential diff V

$E \rightarrow$ [V, E, l] $E = \frac{V}{l}$

as we know $\boxed{I = A V_d n e}$ —— (1)

area of cross section

expression for 'V_d'

$$\vec{F_e} = -e\vec{E}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{-e\vec{E}}{m}$$

$$\int_{u}^{v} \vec{dv} = \int_{0}^{t} -\frac{e\vec{E}}{m} \, dt$$

$$\vec{v} - \vec{u} = \frac{-e\vec{E}}{m} t$$

time interval b/w two successive collision

$$\vec{v} = \vec{u} - \frac{e\vec{E}}{m} t \quad \text{—— (2)}$$

$$\vec{v} = \vec{u} - \vec{a}t$$

due to random motion

note -
drift velo is oppo of EF

· Vavg = drift velo

~~averaging~~

$$\langle \vec{V} \rangle = \langle \vec{u} \rangle - \frac{e\vec{E}}{M} \langle t \rangle$$

random motion ke karan

$$\vec{V}_d = 0 - \frac{e\vec{E}}{M} \tau$$

$\tau \rightarrow$ relaxation time

$$\boxed{\vec{V}_d = \frac{eE}{m} \tau} \quad \text{——— (2)}$$

magnitude of drift velocity.

from (1) & (2)

$$I = \left(A \left(\frac{eE}{m} \tau \right) ne \right) \qquad \left\{ E = \frac{V}{l} \right\}$$

$$I = \frac{Ae^2 n\tau \cdot V}{ml}$$

$$V = \left(\frac{ml}{Ae^2 n\tau} \right) I$$

$\boxed{V \propto I}$ Ohm's law

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$\boxed{V = IR}$.

mass of e

$R = \dfrac{m}{e^2 n \tau} \dfrac{l}{A}$

$\boxed{R = \dfrac{\rho l}{A}}$

length

area of cross section

Resistance of wire

resistivity of material / Specific resistance

$\rho = \dfrac{m}{e^2 n \tau}$

R depends on :—

1) geometry of wire — i.e. l, A
2) material — n, τ
3) Temp. — $\tau \leftarrow$ depends on temp.
(temp $\uparrow$ $\tau \downarrow$)

Note →

$I = \dfrac{A e^2 n \tau}{m l} . V$

$\dfrac{I}{A} = \dfrac{e^2 n \tau}{m} . E$

$\boxed{\dfrac{V}{l} = E}$

Current density

$J = \dfrac{E}{\rho}$

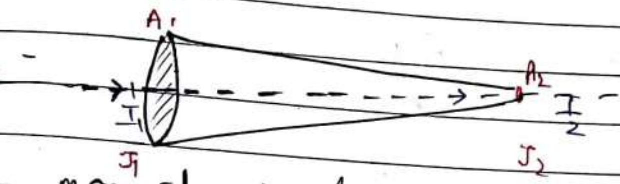
or $\boxed{J = \sigma E}$ or $\boxed{E = \rho J}$

Current density $\left(\dfrac{e^2 n \tau}{m}\right)$ conductivity $= \dfrac{1}{\rho}$

Basic Resistance

In a elc circuit Resistance is show b. —ww—

Note -



nonuniform area of cross section

$I_1 = I_2 = I$ (Same) → rate of flow of charge is same throughout the wire.

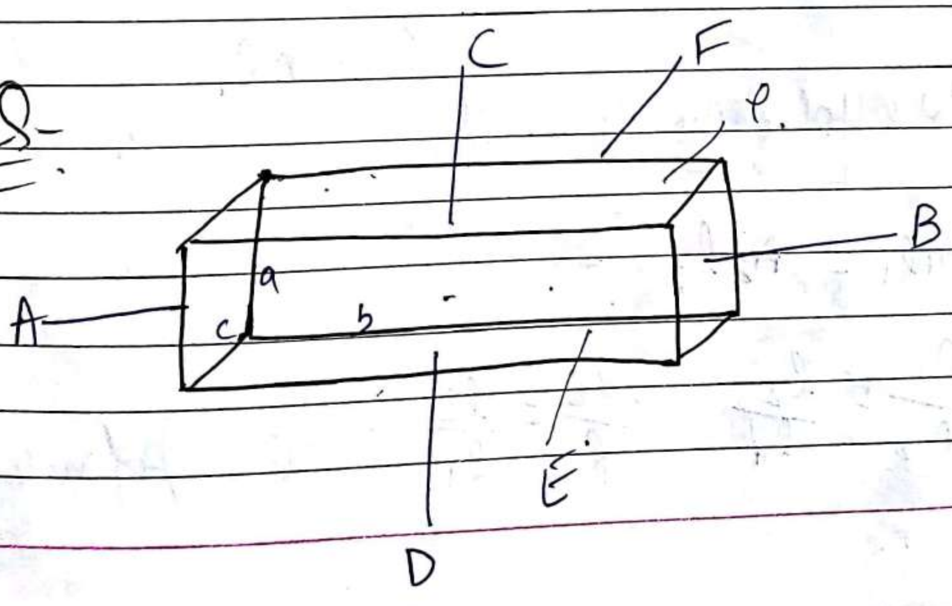
$A V_d n e \xrightarrow{\text{also}}$ same,
$\underbrace{n e}_{\text{const}}$

$A \uparrow$ drift Velo. $\downarrow$.

$$\boxed{A_1 V_{d_1} = A_2 V_{d_2}}$$

$J_1 < J_2$ as $\left(J = \frac{I}{A}\right)$

Q-



find
1) R_{AB}
2) R_{CD}
3) R_{EF}

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1) R_{AB} $\quad \frac{\rho l}{A} = \frac{\rho b}{ac}$

2) R_{CD} $\quad \frac{\rho l}{A} = \frac{\rho a}{bc}$

3) R_{EF} $\quad \frac{\rho l}{A} = \frac{\rho c}{ab}$

Q- A wire of resistance (R) is stretched to double its length. Calculate its new resistance

$V = I R$ $\quad$ (4x)

$$R = \frac{\rho l}{A}$$

$$\frac{R_2}{R_1} = \frac{\rho_2 l_2 A_1}{\rho_1 l_1 A_2} \quad \text{—(1)}$$

$l_2 = n l_1$

total $\boxed{\text{vol of wire is const}}$.

$$A_1 l_1 = A_2 l_2$$

$$\frac{A_1}{A_2} = \frac{l_2}{l_1} \qquad = \frac{R_2}{R_1} = \frac{l_2}{l_1} \quad \text{—(2)}$$ put in (1)

as volume.

$\frac{R_1}{R_2} = \frac{\rho_1 L_1 A_2}{A_1 \rho_2 L_2}$

as volume is same.

$A_1 L_1 = A_2 L_2$

$\frac{L_1}{L_2} = \frac{A_2}{A_1}$

$\frac{R_1}{R_2} = \left(\frac{L_1}{L_2}\right)^2$

$4R_1 = R_2$

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$$\frac{R_2}{R_1} = \left(\frac{l_2}{l_1}\right)^2$$

$$\frac{R_2}{R_1} = \left(\frac{2l_1}{l_1}\right)^2 \Rightarrow \boxed{R_2 = 4R_1}$$

Q3 - Wire is stretched to change its length by ~~0.0~~ 0.1%. Calculate % change in resistance.

$$\frac{R_2}{R_1} = \left(\frac{l_1+0.1}{l_1}\right)^2 = \frac{1+0.1}{1}$$

$$1.0(1+0.1)^2$$

$(0.1)^2$

$0.\frac{1}{10}\times 1 \quad (0.01)$

$l_1 + (.0.1)^2$

~~0.001~~

$\frac{1}{10}\times\frac{1}{10} \quad \frac{1}{100}$

$\boxed{.001}$

$(1.1)^2$

1.21

% change in resistance

$$\left(\frac{R_2 - R_1}{R_1}\right)\times 100$$

$$l_2 = l_1 + l_1\frac{x}{100}$$

$$\frac{l_2}{l_1} = \left(1+\frac{x}{100}\right) \quad \text{—— (1)}$$

$$\boxed{A_1 l_1 = A_2 l_2}$$

$$\frac{R_2}{R_1} = \left(\frac{l_2}{l_1}\right)^2$$

$$R_2 = \left(1 + \frac{x}{\ }\right)^2$$

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$$\boxed{\left[\left(1+\frac{x}{100}\right)^2-1\right]\times 100}$$

~~for eg - if length is 100%~~ increased then R increases by 300%

& if $x \rightarrow$ very small change.

expanding ~~binomial~~ binomially

$$\left(\cancel{1}+\frac{2x}{100}-\cancel{1}\right)\times 100$$

$= .2x$. ~~%~~ $\boxed{0.2\%}$

Note -

$$R = \frac{\rho l}{A}$$

$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + \frac{\Delta l}{l} - \frac{\Delta A}{A} \quad (1)$$

$$V = A.l = \text{const}$$

$$\frac{\Delta V}{V} = \frac{\Delta A}{A} + \frac{\Delta l}{l} = 0$$

$$\frac{\Delta R}{R} = 2\frac{\Delta l}{l}.$$

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$$\left(\frac{\Delta R}{R}\times 100\right) = 2\left(\frac{\Delta l}{l}\times 100\right)$$

$$= 2\times 0.1$$
$$= 0.2\%$$

Effect of temp

α — temp coeff of resistivity

$$\boxed{\alpha = \frac{1}{\rho}\frac{d\rho}{dT}}$$

fractional change in resistivity per unit change in temp

→ α = const

$$\int_{\rho_1}^{\rho_2}\frac{d\rho}{\rho} = \alpha\int_{T_1}^{T_2} dT$$

$$\ln\frac{\rho_2}{\rho_1} = \alpha(T_2 - T_1)$$

$$\boxed{\rho_2 = \rho_1 e^{\alpha(T_2 - T_1)}}$$

α exponentially increasing

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$R = \frac{\rho l}{A}$ neglected as its very small ratio

$\frac{l}{A}$ neglecting as its very small change.

$R_2 = R_1 e^{\alpha(T_2 - T_1)}$

If $\alpha(T_2 - T_1) << 1$

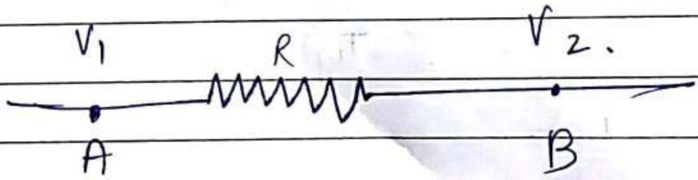
$$\boxed{\rho_2 = \rho_1 \left[1 + \alpha(T_2 - T_1)\right]}$$

$\left\{ e^x = \underbrace{1 + x}_{} + \underbrace{\frac{x^2}{2!} + \ldots}_{\text{neglect}} \right\}$

$$\boxed{R_2 = R_1 \left[1 + \alpha(T_2 - T_1)\right]}$$

Current in a resistance

higher $\rightarrow$ lower.



Current in resistance always flows from higher potential to lower potential.

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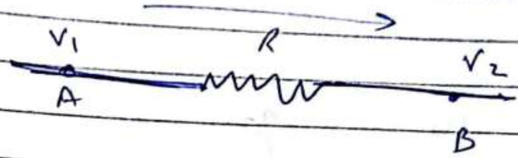
① if $V_1 > V_2$

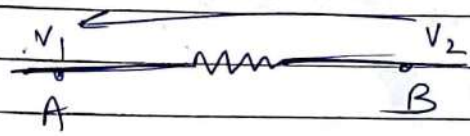
$$\boxed{I = \frac{V_1 - V_2}{R}}$$



dir A → B

② if $V_2 > V_1$

$$\boxed{I = \frac{V_2 - V_1}{R}}$$

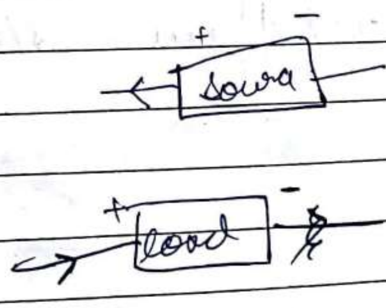


dir B → A

Power in Electric circuit

energy liberated in one second in any electric device is called its power.

elements — Source
elements — load



DPP-17

full gravitation

$$I = \frac{dq}{dt} \quad \text{——— (1)}$$

$$dw = v.dq$$

now [illegible]

$$\frac{dw}{dt} = v\frac{dq}{dt}$$

$$= VI$$

rate of work $= VI$

$$\boxed{(P)\ \text{Power} = VI}$$

~~voltage~~ current

Potential diff

→ if power is constant

$$E = P.t$$

energy liberated in time t

→ power variable (it's function of time)

$$E = \int_0^t P.dt$$

unit of power = J/sec or watt

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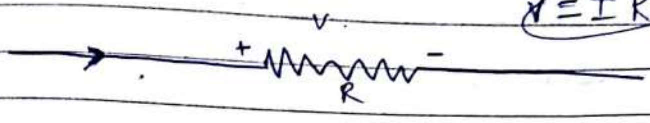
Power consumed in a resistor

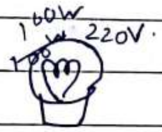
$V = IR$



$$\boxed{P = VI}$$
$$= I^2 R$$

$$\boxed{P = I^2 R} \quad \text{or} \quad \boxed{P = \frac{V^2}{R}}$$

Note



{if connected to 220V volt then it will consume 100 J/sec / 100W power}

Resistance of bulb.

$$R = \frac{V^2}{P} \qquad \frac{(220V)^2}{100W} \qquad 484$$

$$R = \frac{220 \times 220}{100} = 484\,\Omega.$$

Or ~

(200W) (100W) (50W)

in series

Rmax most bright

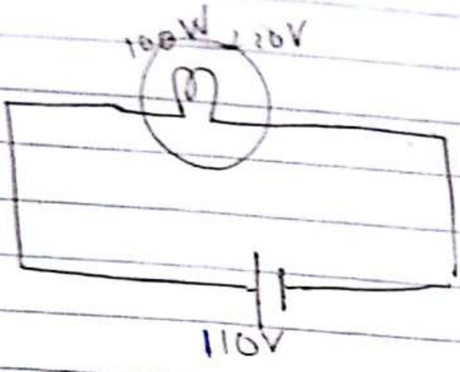
too

most bright

(200 W) (100 W) (50 W)

in parallel

* Calculate power consumed by bulb



$$R_B = \frac{(220)^2}{100} = 484\ \Omega.$$

$$P_{\text{ower bulb}} = \frac{V^2}{R_b} = \frac{(110)^2}{484}.$$

$$P_B = 25W$$

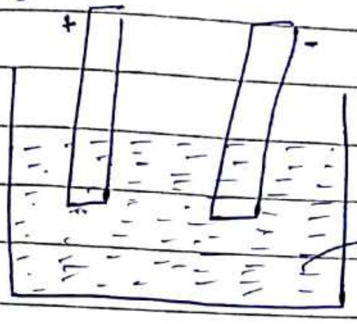
Battery / Cell

It is a device which maintains a const potential diff across its terminal

battery is prepared by putting two rods of of diff metal in a chemical solution.

chemical energy ⟶ electric energy.

battery force : F_b non electrostatic.



electric field → due to charges on rod.
(due to charge on rod)

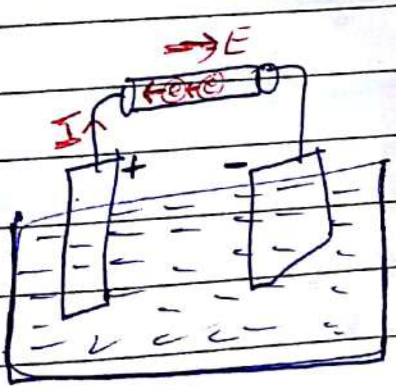
$F_e = (qE) =$

electron force

at Steady State

$F_b = F_e$.

battery force balances electrostatic force (charge)



charge को pure me ghumane ke liye battery jimmedar

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Internal resistance of Battery
(depends on diff. things below)

1) $r \propto d$ — separation between plates

2) $r \propto C$ — conc. of electrolyte

$r \propto \frac{1}{S}$ S → area of plate

$r \propto \frac{1}{T}$ T → temp

* meaning of 10 Amp/hr
(battery 10 amp ke saath 1 ghanta chalegi)

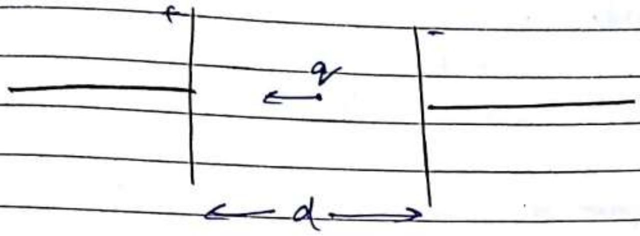
if 10 amp current is withdrawn from the battery then it will work for 1 hour

or 1 amp → 10 hrs.
$\frac{1}{2}$ amp → 20 hrs

Electromotive force

CI → | Ex1 & Part I: 1st A, 1st B, | Part II: 1st A, 1st B | DPP → next

Electromotive force (EMF) of battery



$$E = \frac{W_b}{q}$$

It is the work done by battery force per unit ~~force~~ charge

unit = $\frac{\text{Joule}}{\text{Coulomb}}$ = Volt(V) like Potential diff. unit

* when cell is not externally connected

W $\quad (F_b = F_E)$

$= q\,E$

electric field.

$$W_B = F_b \cdot d$$
$$= (q\,E \cdot d)$$

$$\boxed{W_b = q.V}$$ V = potential diff

EMF

$$E = \frac{q \cdot V}{q} = V$$

work char per unit char

$$E = V$$

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Note

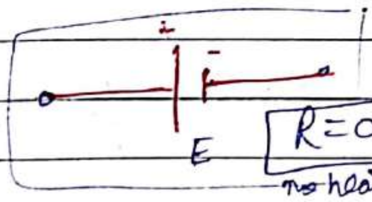
EMF & Potential diff are two diff quantities.
EMF is work done by battery force which is non-electrostatic.

due to V — electric field created by charges accumulated on rods of battery which is electrostatic

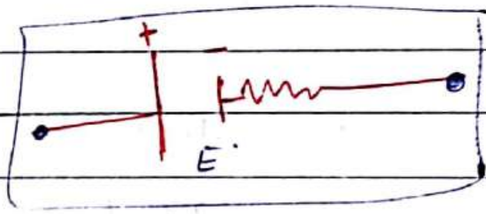
EMF — non-electrostatic

& Potential diff is produced by electric fields due to charges accumulated on plates which is conservative.

Representation of battery

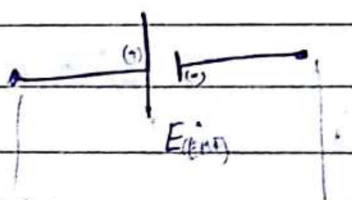


ideal battery —
$R = 0$
no heating effect.



non ideal battery

Note



Potential E or agar $x+E$

Potential $= 0$ if x

$V_A - V_B$ = terminal voltage of battery

iske hamesa yeh wala E jyada hoga

→ +ve se nikle to Source

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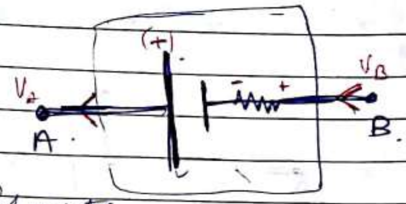
Battery as a Source

$V_A - E + I r = V_B$

$\boxed{V_A - V_B = E - IR}$ —— (1)



terminal voltage = $E - IR$ ← Emf se chota

the rate at which the chemical energy is consumed in battery $= EI$

↑ current flowing

$EI - I^2R$ → the rate at which heat is generated inside batte

↑ Ohmic heat

~~the output power~~ $= EI - I^2R$

So output power = Energy supp - heat used

$\cancel{EI} \cancel{e-} \; IR^2 \cancel{R} = E - \cancel{I}R$

$(EI - I^2R)$

$I(E - IR)$

from (1)

$$P = \boxed{I(V_B - V_A)}$$

current, terminal voltage

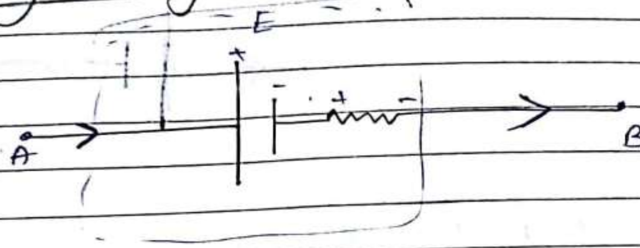
$I = ... \times V$

$V \cdot ds = I$

$3.2 = 5 \times 10^3 \times X$

$X = \frac{3.2}{5 \times 10^3}$

Battery acting as load



$V_A - E - IR = V_B$

$\boxed{V_A - V_B = E + IR}$

the rate at which chemical energy is stored (EMF se bada) in battery is EI

(jyoda donge to median milega) I^2R for se heat pe roopne nite

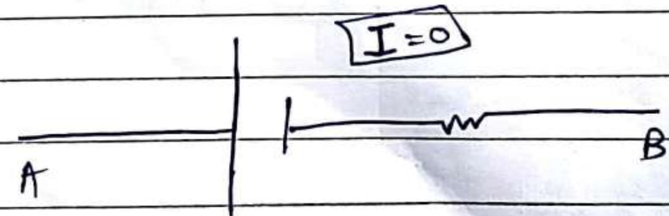
Power descipated $= I^2R$

Input power (power given to battery) $= EI + I^2R$

$= I(E + IR)$

$\boxed{P = I(V_A - V_B)}$

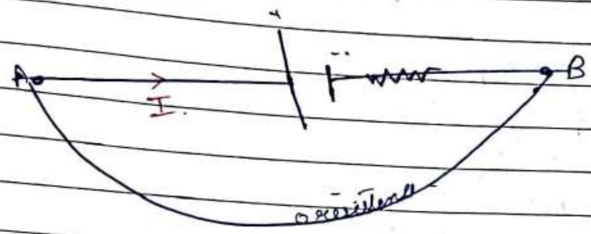
Note open circuit



thus $(V_A - V_B) = E$

$P_{av} = V I.$
Power avg

Short cir circuit



connected by oresistance.

$V_A - V_B = 0 \leftarrow = I R_{(0)} = V$
$= 0.$

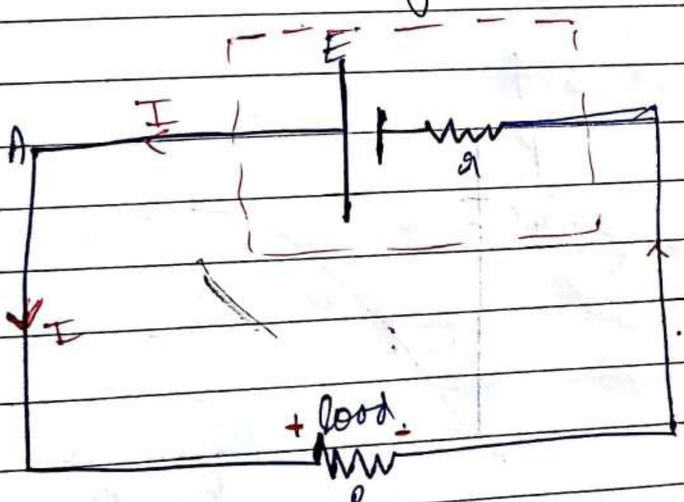
$V_A = V_B$

terminal voltage = $V_A - V_B = (E - IR) = 0$

$E = IR$

current $\boxed{I = \dfrac{E}{R}}$

Max power tranfor theorem



terminal voltage of cell

$V_A - V_B = E - Ir$ —(1)

$I = \dfrac{V_A - V_B}{R}$ —(2)

from (1)&(2)

$\boxed{I = \dfrac{E}{R + r}}$ net EMF / total resistance

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Power delivered in load.

$$P = I^2 R$$

$$\boxed{= \frac{E^2 R}{(R+r)^2}}$$

For max power in load R

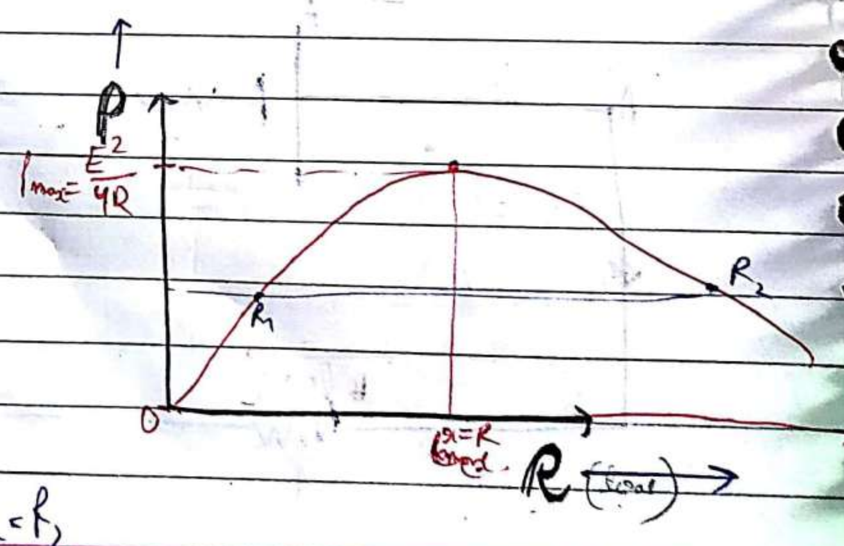
$$\frac{dP}{dR} = 0$$

$$\frac{d}{dR}\left[\frac{R}{(R+r)^2}\right] = 0$$

diff

$$\boxed{R = r}$$

$$\boxed{P_{max} = \frac{E^2}{4r^2}}$$



$R = R_1 \quad R = R_2$

Power same.

Scanned by CamScanner

$R(R+r)^2 - E^2 R = 0$

expanding

$P(R^2 + r^2 + 2Rr) - E^2 R = 0$

$$\boxed{R^2 + \left(2r - \frac{E^2}{P}\right)R + r^2 = 0}$$

R_1

R_2

quad eq whose roots are R_1 & R_2.

$R_1 R_2 = r^2$

$r = \sqrt{R_1 \times R_2}$

EFFICIENCY OF CELL

$= \dfrac{\text{output power}}{\text{total energy spend by battery}}$

$\dfrac{I^2 R}{I^2 R + I^2 r} \times 100\%$

$\left(\dfrac{R}{R+r}\right) \times 100$

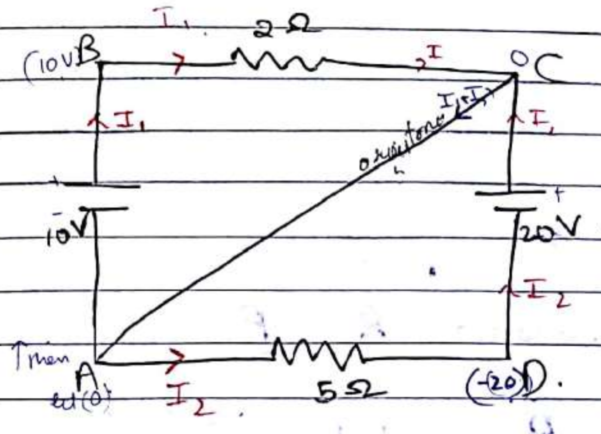
$\dfrac{60}{60+6r} \times 10$

at max power 50% efficiency.

if $V_1 > V_2$ $\quad \frac{V_1}{A}$ —ww— V_2

$\boxed{I = \frac{V_1 - V_2}{R}}$

Circuit problem



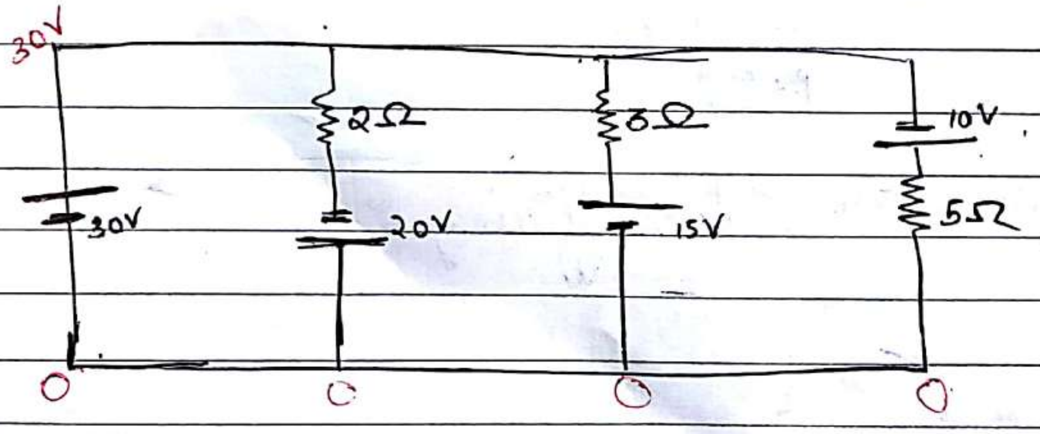
find of current in each branch of circuit.

$$I_1 = \frac{10-0}{2} = 5A \checkmark \qquad I_2 = \frac{0-(-20)}{5} = 4A \checkmark$$

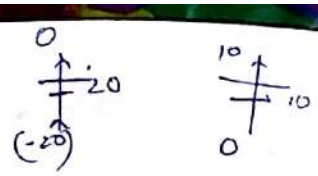
thus current in CA = $I_1 + I_2$
$= 4 + 5$
$= 9A$

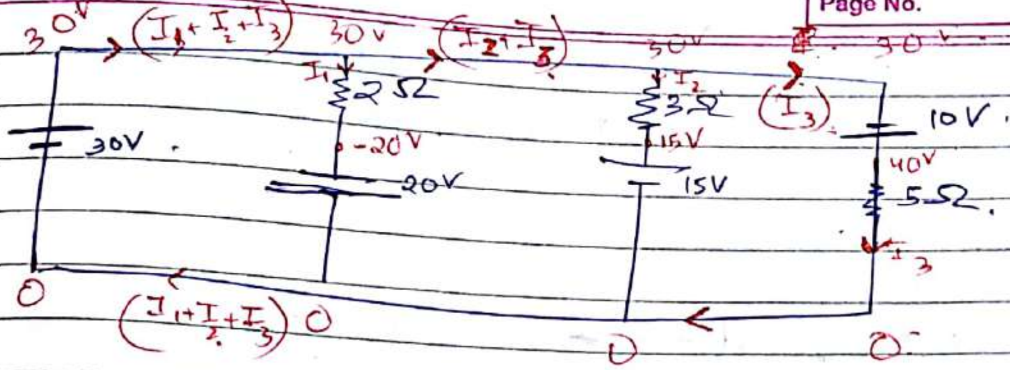
this we solved by zero potential method.

Q.



Current flowing in each branch of circuit





$$I_1 = \frac{30-(-20)}{2} = 25A.$$

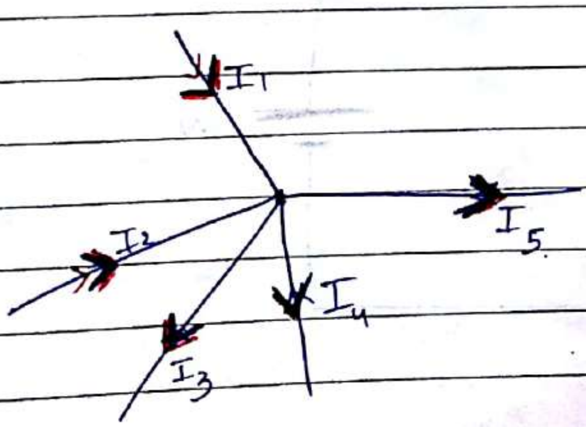
$$I_2 = \frac{30-15}{3} = 5A$$

$$I_3 = \frac{40-0}{5} = 8A.$$

Kirchoff's law for current distribution

1) Kirchoff current law (KCL) / Junction law

It is based on the conservation of charge.



the algebraic sum of all current meeting at a point (junction)

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in any electric or circuit is always zero.

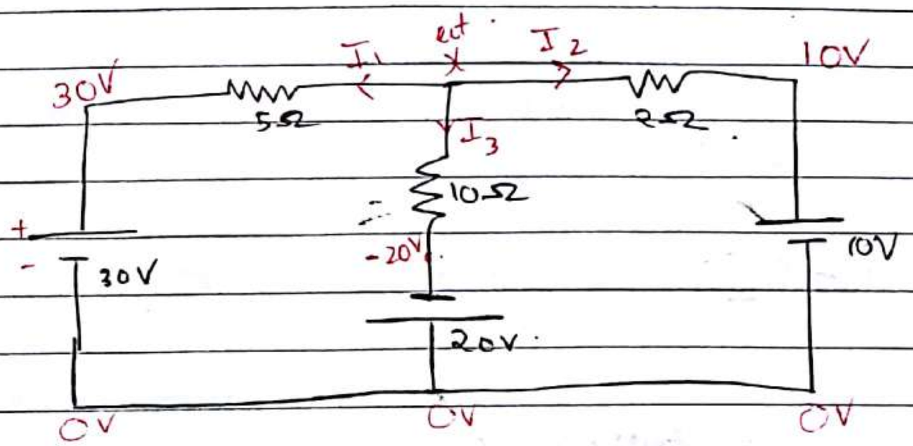
ie $\boxed{\Sigma i = 0.}$

by KCL = $I_1 + I_2 + I_3 - I_4 - I_5 = 0.$

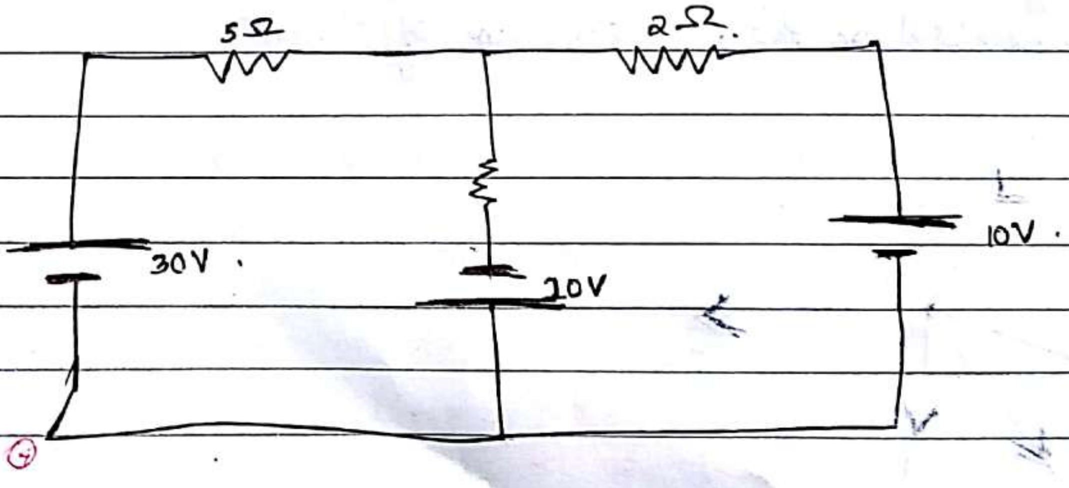
$$\boxed{I_1 + I_2 = I_3 + I_4 + I_5}$$

let x is by

Q



find current flowing in each branch of circuit



using KCL

$$I_1 + I_2 + I_3 = 0.$$

$$\frac{(x-30)}{5} + \frac{x-10}{2} + \frac{x-(-20)}{10} = 0.$$

$$\frac{2x-60+5x-50+x+20}{10} = \frac{8x-90}{10} = 0.$$

$$x = \frac{90}{8} = \frac{45}{4}\,V \text{ ans}$$

now $I_1 = \dfrac{\left(\frac{45}{4} - 30\right)}{5} = \dfrac{\frac{45-30\times 4}{4}}{5} = \dfrac{-75}{20}\,A$ $\quad \frac{120}{45}$

thus < wali sign nhi I_1 > ja rhi he.

$I_2 = \dfrac{\frac{45}{4} - 10}{2} = \dfrac{5}{8}\,A.$ thu >

$I_3 = \dfrac{\frac{45}{4} + 20}{10} = \dfrac{125}{40}\,A$ V ja rhi he

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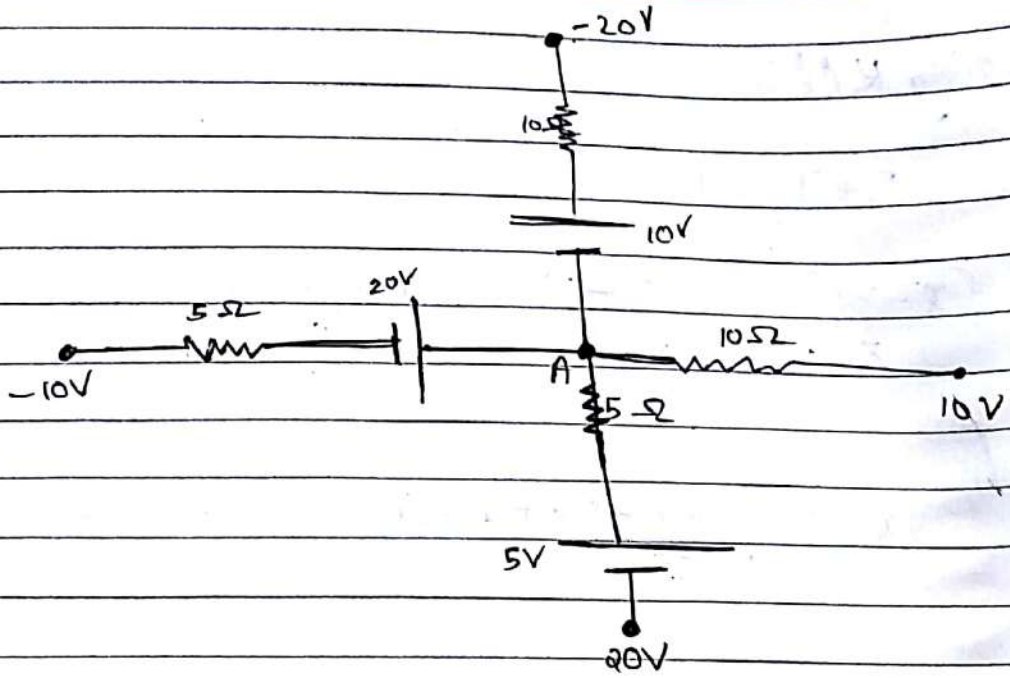
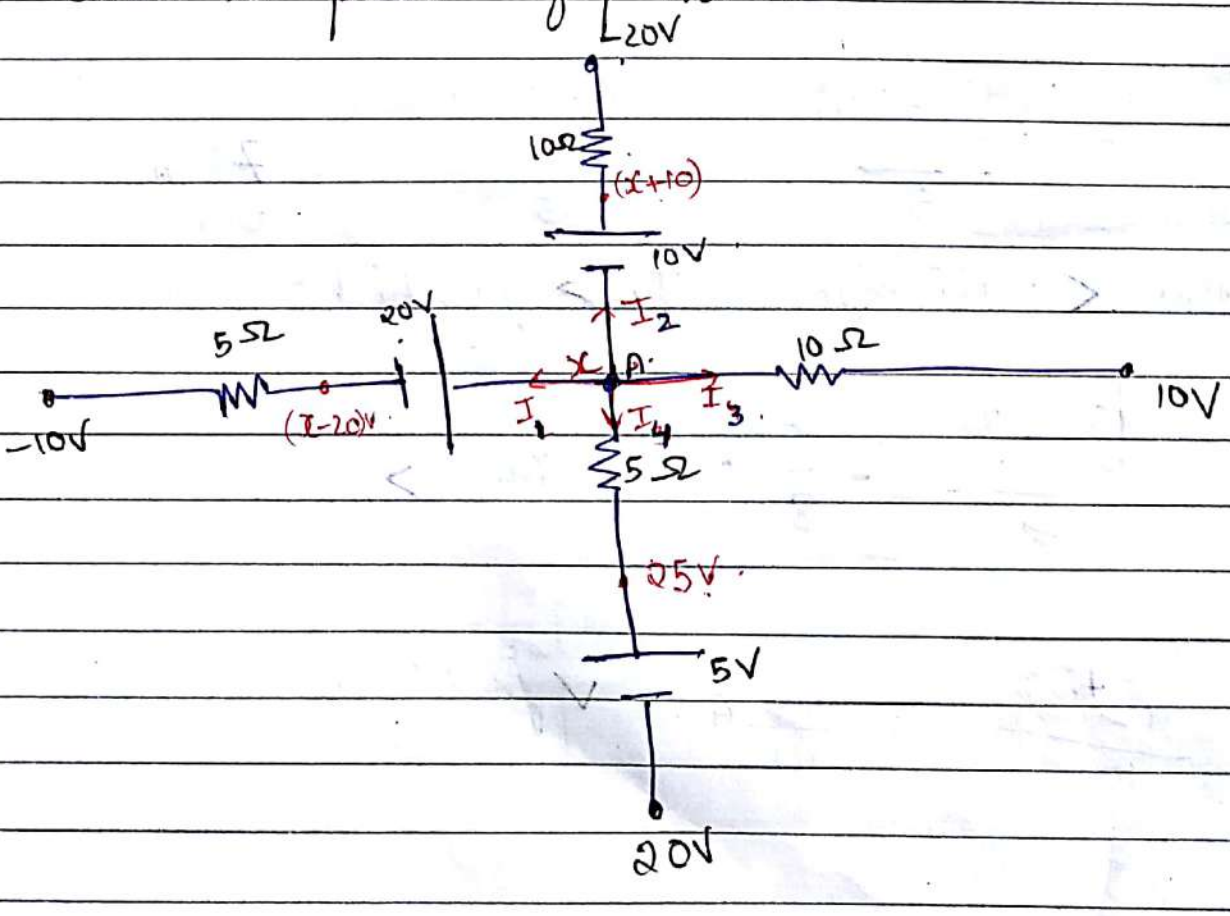


Calculate potential of point A



$I_1+I_2+I_3+I_4=0$.

~~$\Sigma I = \frac{x-20+10}{}$~~

$$\Sigma I = \frac{x-20\overset{-(-10)}{+10}}{5}+\frac{x+10-(-20)}{10}+\frac{x-10}{10}+\frac{x-25}{5}=0$$

$$x=\frac{25}{3}$$

Kirchoff Voltage law KVL

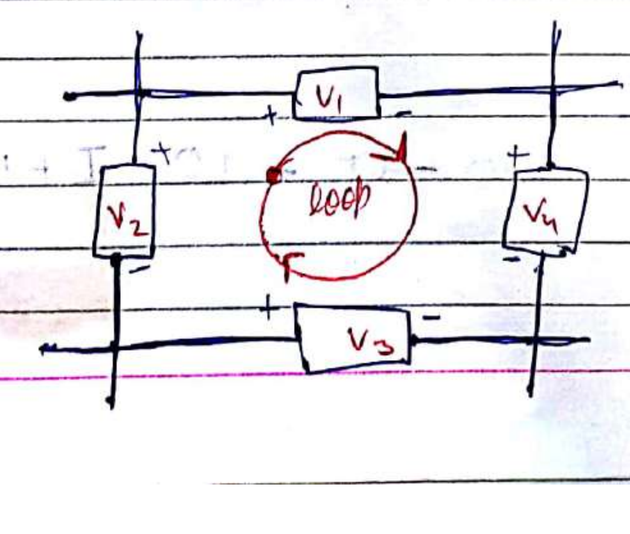
based on cons of energy

It is based on conservation of energy.

the algebric sum of potential differencs across each element in any closed path or loop in any ~~clos~~ cirumt is always zero

i.e. $\boxed{\sum \Delta V = 0}$

□ → can be battery or resistance

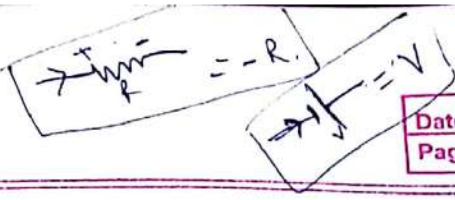


using KVL in loop

$-V_1-V_4+V_3+V_2=0$

potential gain = +ve

potential drop = -ve.



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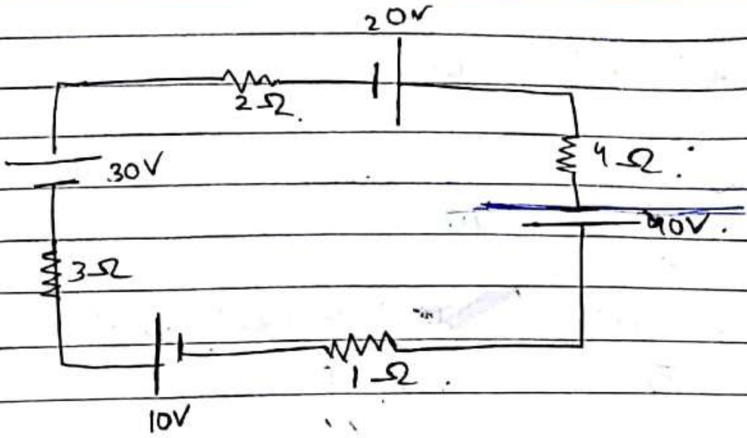
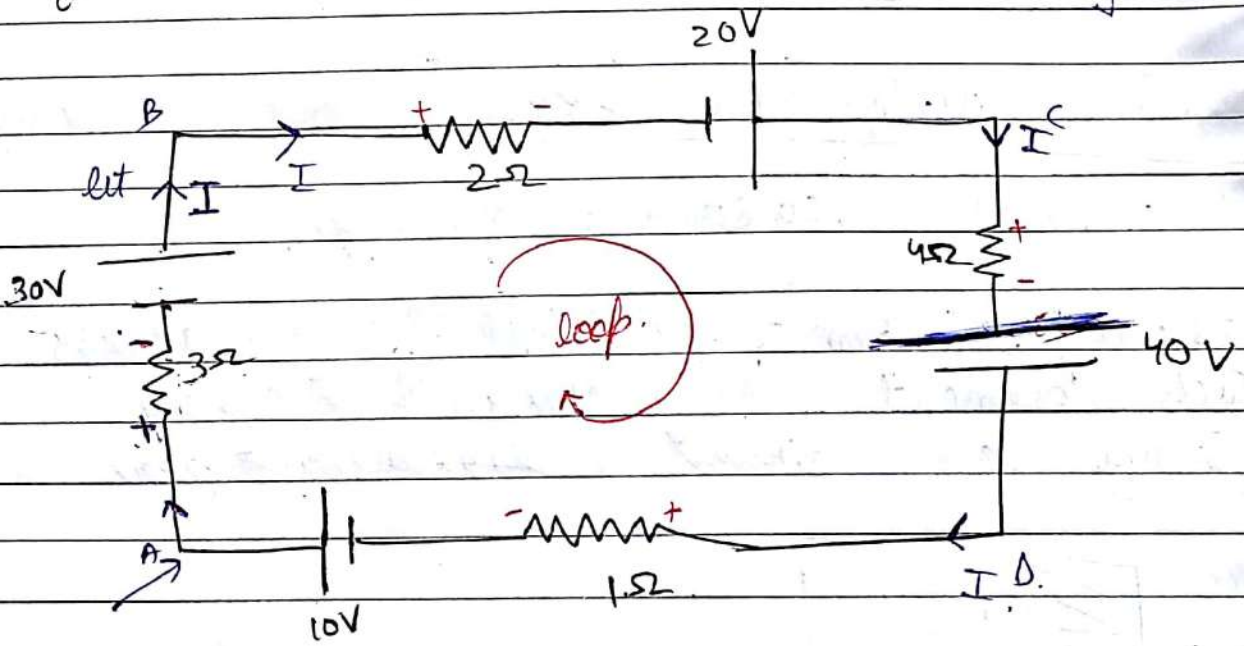


find current flowing in electric circuit



let current I flows thru circuit

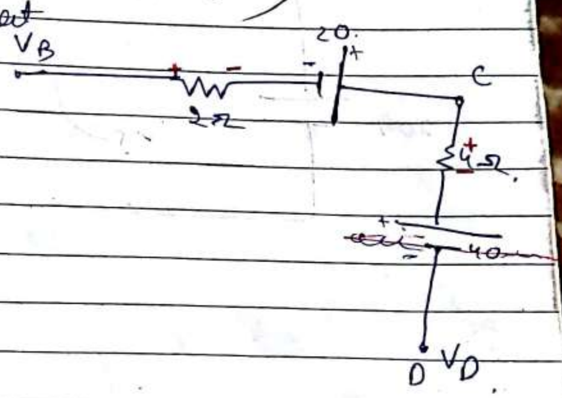
V=IR

by KVL

$$-3I + 30 - 2I + 20 - 4I - 40 - I + 10 = 0$$

$$I = 2A$$

find $V_B - V_D$ or (also find diff of Potential of pt B & potential of pt D)



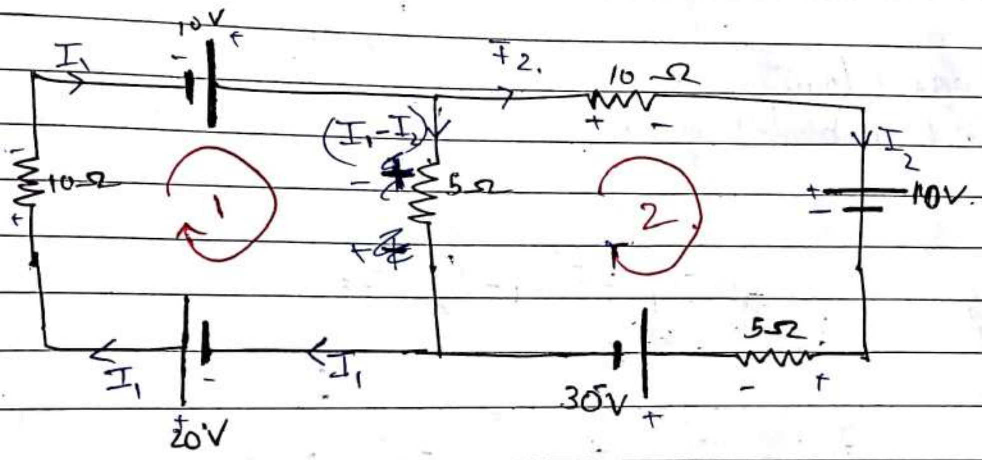
$V_B - 2I + 20 - 4I - 40 = V_D$

put value of $I = 2A$.

$V_B - 4 + 20 - 8 - 40 = V_B$

$V_B - V_D = 32$.

Q —



find current in each branch of circuit

let current flow is I_1

by KVL

in loop (1)

$$-10I + 10 - 5(I_1 - I_2) + 20 = 0$$

$$3I_1 - I_2 = 6 \longrightarrow (1)$$

in loop (2)

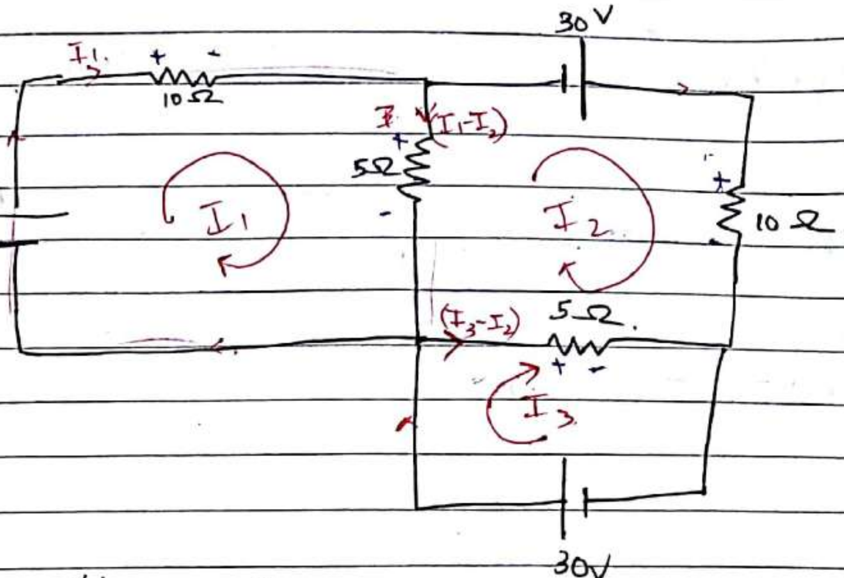
$$-10I_2 - 10 - 5I_2 - 30 + 5(I_1 - I_2) = 0$$

$$I_1 - 4I_2 = 8 \longrightarrow (2)$$

by (1) & (2) $I_1 = \frac{16}{11} A$ $I_2 = \frac{-18}{11} A$

$I_1 \uparrow \downarrow I_2$ ← ye home nahi he ki niche ($\downarrow I_1 - I_2$)

Q



KVL

Q = Current flowing in each branch of circuit

using KVL loop①

$$+20 - 10I_1 - 5(I_1 - I_2) = 0 \quad \text{——— (1)}$$

loop②

$$30 - 10I_2 + 5(I_3 - I_2) + 5(I_1 - I_2) \quad \text{——— (2)}$$

loop③

$$-5(I_3 - I_2) + 30 = 0 \quad \text{——— (3)}$$

from ① & ② & ③

$I_1 = 3$ A

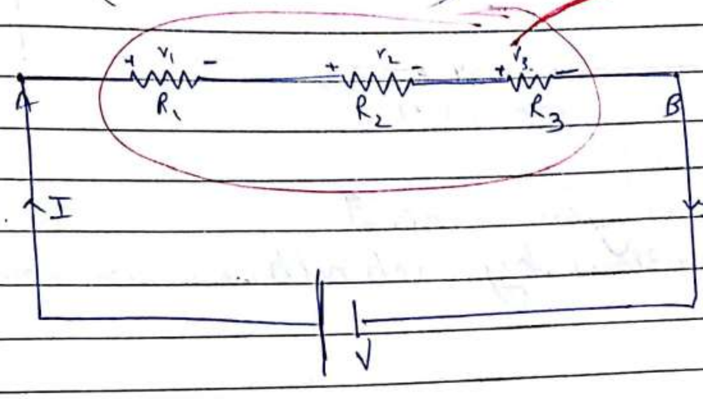
$I_2 = 5$ A

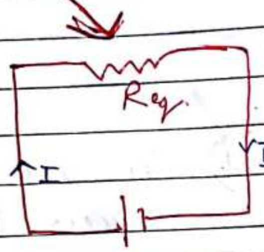
$I_3 = 11$ A

Ex I | Part I | II
C | C

8 - Combination of resistances

1) **Series** (end to end connect)





$$\boxed{V = I R_{eq}}$$

using KVL

$$V - V_1 - V_2 - V_3 = 0$$

$$V = V_1 + V_2 + V_3$$

~~IReq = V1+V.~~

$$\cancel{I} R_{eq} = \cancel{I} R_1 + \cancel{I} R_2 + \cancel{I} R_3$$

$$\boxed{R_{eq} = R_1 + R_2 + R_3}$$

$$V_1 = I R_1 = \frac{VR}{R_{eq}} = \frac{V R_1}{R_1 + R_2 + R_3}$$

$$V_2 = I R_2 = \frac{V R_2}{R_1 + R_2 + R_3}$$

$$\boxed{V_1 : V_2 : V_3 = R_1 : R_2 : R_3}$$

so

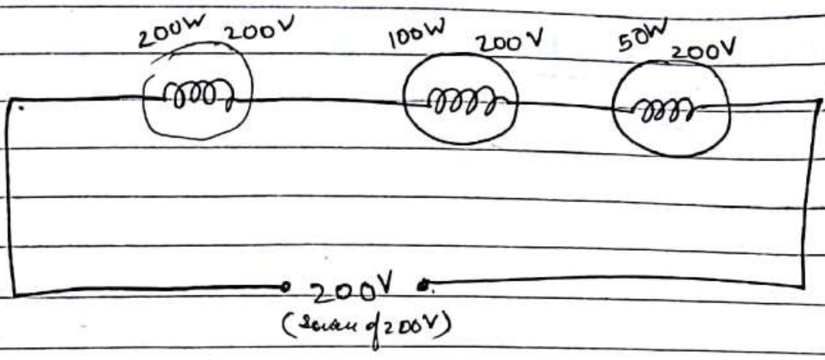
$$P_1 = I^2 R_1 \qquad P_2 = I^2 R_2 \qquad P_3 = I^2 R_3$$

$$\boxed{P_{net} = I^2 R_{eq}} \qquad \boxed{P_1 : P_2 : P_3 = R_1 : R_2 : R_3}$$

$V = IR$.

V/I

Q -



1) Current flowing in circuit.
2) Power consumed by each bulb (which will show more light)

$R_1 \quad R_2 \quad R_3$

$P = I^2R \quad \frac{(200)^2}{200} + \frac{(200)^2}{100} + \frac{(200)^2}{50}$.

$R = \quad 200 \quad 400 \quad 800$.

$R_{eq} = 1400$.

$R_1 = \frac{(200)^2}{200} = 200$, $R_2 = \frac{(200)^2}{100} = 400$, $R_3 = \frac{(200)^2}{50} = 800$.

$I = \frac{200}{R_1+R_2+R_3} = \frac{200}{1400} = \frac{1}{7}$. ✓

$V = IR$ as $\boxed{P = I^2R}$

$P_1 = I^2R_1 = \left(\frac{1}{7}\right)^2 \times 200$ | $P_2 = I^2R_2 = \left(\frac{1}{7}\right)^2 \times 400$ | $P_3 = I^2R_3 = \left(\frac{1}{7}\right)^2 \times 800$

most brightest

$\boxed{P_3 > P_2 > P_1}$

most power consumption

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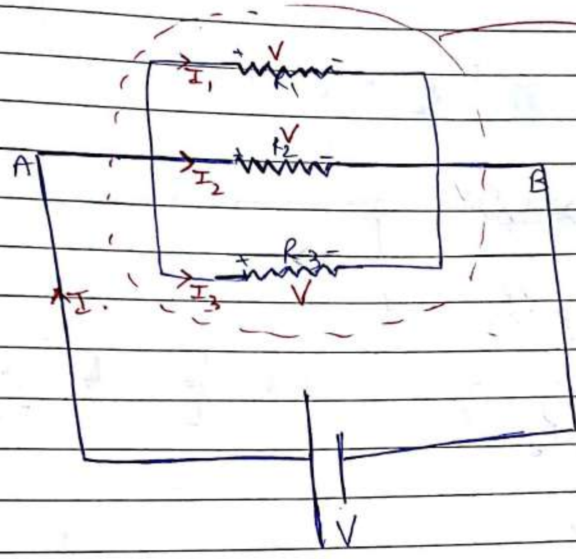
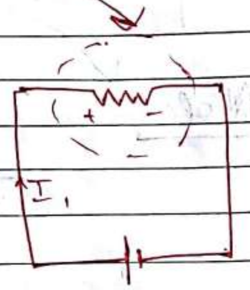
2) Parallel combination





$\boxed{V = I R_{eq}}$

KCL

$$I = I_1 + I_2 + I_3$$

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$I_1 = \frac{V}{R_1} = \frac{I R_{eq}}{R_1} = \frac{I}{\frac{R_1}{\frac{1}{R_{eq}}}} = \frac{\frac{I}{R_1}}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)} = \boxed{\frac{I G_1}{G_1 + G_2 + G_3}}$$

$$I_2 = \frac{\frac{I}{R_2}}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)} = \boxed{\frac{I G_2}{G_1 + G_2 + G_3}}$$

$\boxed{G = \frac{1}{R}}$

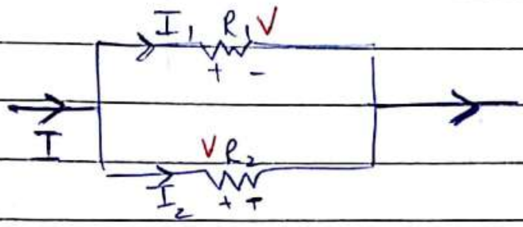
conductance

resistance

$$\boxed{I_1 : I_2 : I_3 = \frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3}}$$

$$\boxed{P_1 : P_2 : P_3 = \frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3}}$$

<u>Note</u> –



$$\boxed{I = I_1 + I_2}$$

$$V = V$$

$$I_1 R_1 = I_2 R_2$$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

$$\frac{I_1}{I_1 + I_2} = \frac{R_2}{R_1 + R_2}$$

$$\boxed{I_1 = \frac{I R_2}{R_1 + R_2}} \qquad \boxed{I_2 = \frac{I R_1}{R_1 + R_2}}$$

773 769

773 776 7709

$\frac{a}{b} = \frac{c}{d}$

icon
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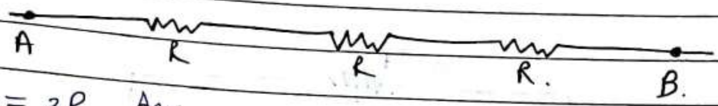
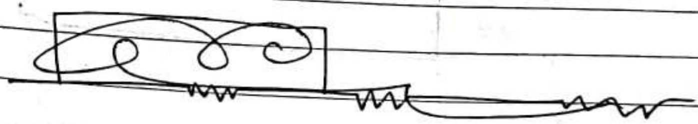
Q -

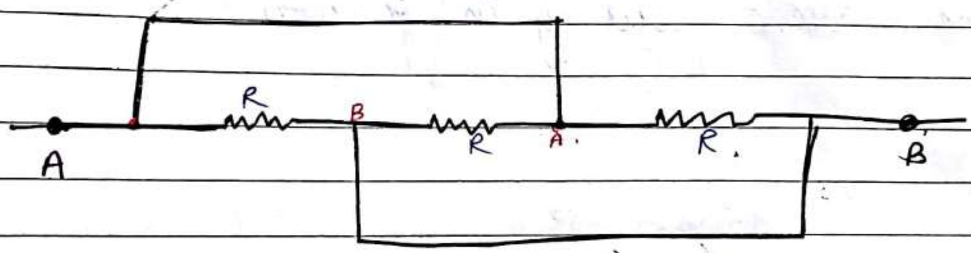


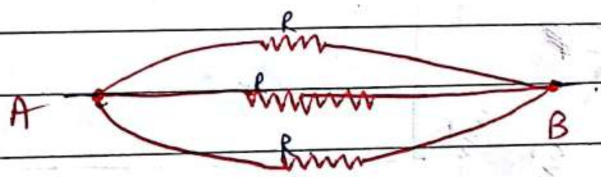
$R_{eq} = 3R$. Ans



Q Calculate R_{eq} b/w A & B (zero resistance wire is used)

same potential



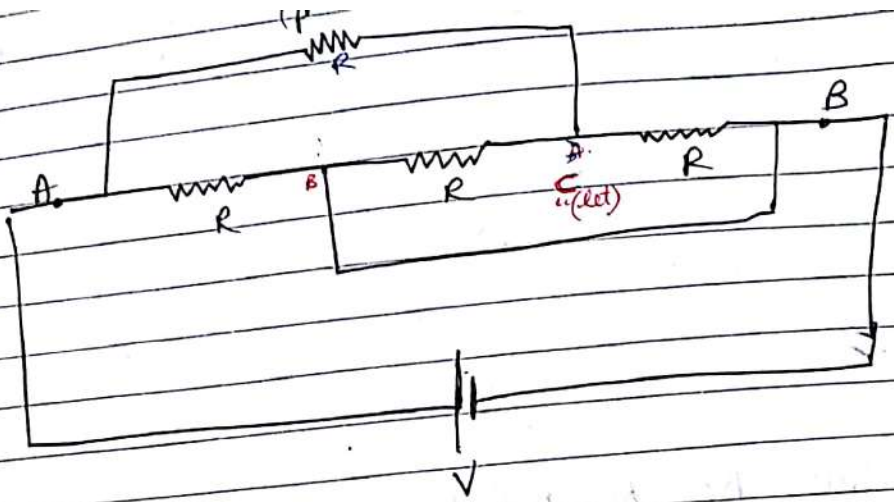


$R_{eq} = \frac{R}{3}$ Ans

$\frac{1}{R} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}$

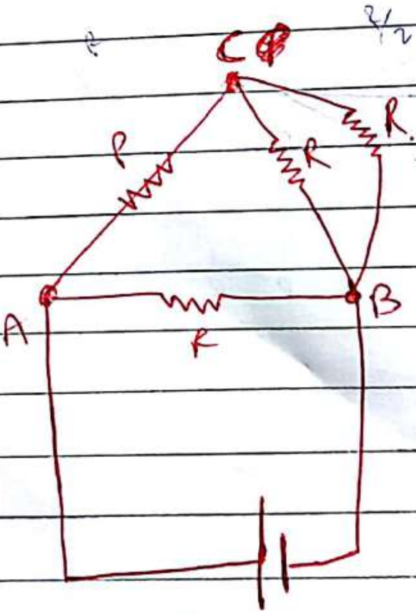
$R = \frac{R}{3}$

Q -



find current flowing in resistor P

A — B



$$R_{eq} = \frac{\frac{3R}{2} \cdot R}{\frac{3R}{2} + R} = \frac{\frac{3R^2}{2}}{\frac{3R+2R}{2}} = \frac{3R}{5}$$

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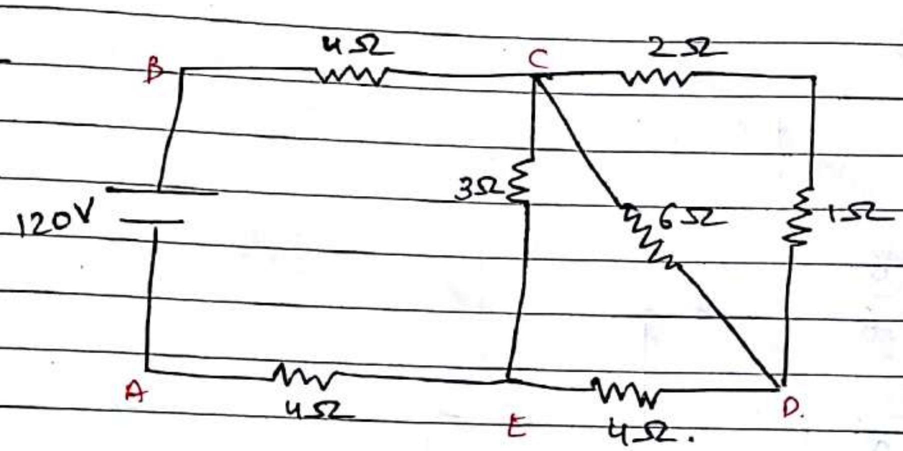
$$I = \frac{V}{R_{eq}} = \frac{5V}{3R}$$

$\frac{2IR}{5R}$

Then $I_1 = \frac{IR}{R + \frac{3R}{2}} = \frac{2I}{3R}$ or $\cancel{\frac{5V}{3R}}$ $\frac{2V}{3R}$.

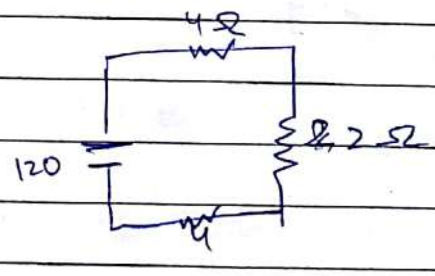
Q



find current flowing in 2Ω resistance.

CD $\frac{3\times6}{3+6} = 2\,\Omega$

~~CD~~ C&E ... at end



$120 = I\,10$

$\boxed{I = 12A}$

$4\overline{)60}$ 15, 4, 20

$\frac{1}{2}+\frac{1}{1}$ $\frac{1+2}{2}$ $\frac{3}{2}$

$\frac{2}{3}+\frac{6}{1}$ $\frac{20}{3}$ $\frac{2+18}{3}$

$\frac{1}{3}+\frac{1}{4}+\frac{3}{20}$

$\frac{20+15+9}{60}$

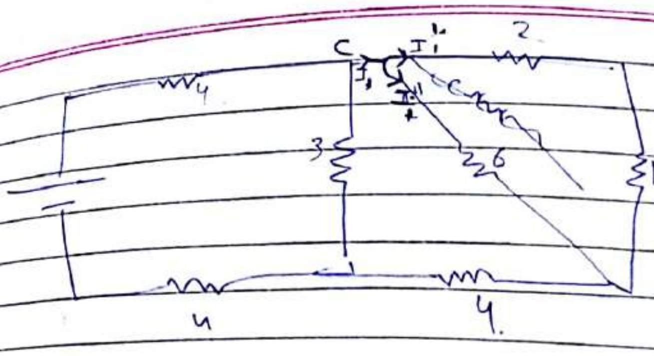
$4\ \frac{1}{4}+4$ $\frac{60}{44}$

$\frac{44}{60}$

$8+\frac{60}{44}$ $\frac{352+60}{44}$

$\frac{11}{103} \times 120 = I$

3, 44, 32, 8, 352, 103, 412, 44, 11



$$I_1 = \frac{12\times3}{3+6}$$

$$\boxed{I_1 = 4A}$$

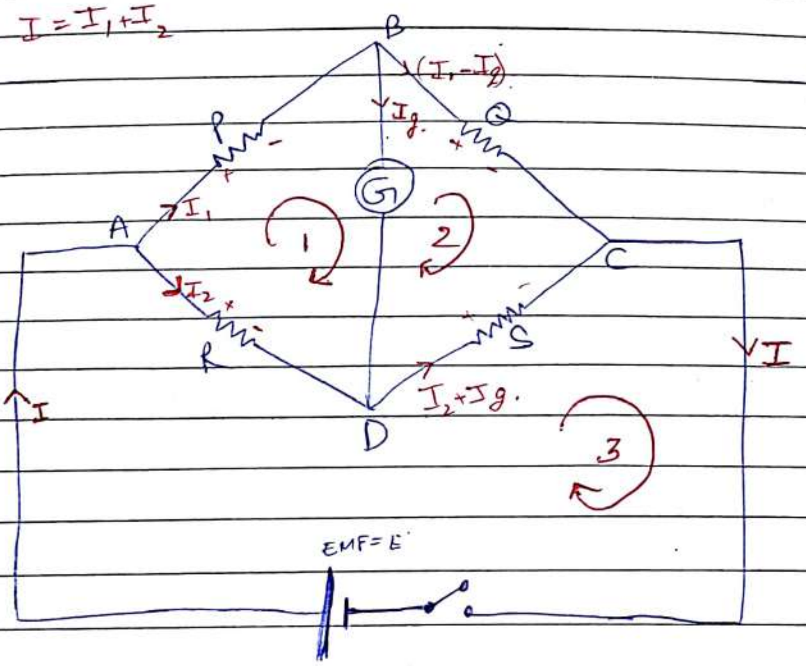
$$I_1' = \frac{4\times6}{3+6}$$

$$\boxed{I_1' = \frac{8}{3}A}$$

Wheat Stone bridge

4 terminal device

$I = I_1 + I_2$



if $I_g = 0$

wheat Stone bridge is balanced

$$\boxed{V_B = V_D}$$

$$\boxed{V_A - V_B} = \boxed{V_A - D_D} \qquad V_B - V_C = V_D - V_C$$

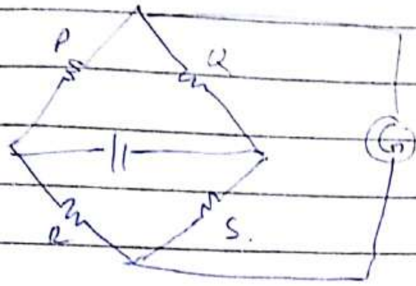
$$I_1 P = I_2 R \quad \text{—(1)} \qquad I_1 Q = I_2 S \quad \text{—(2)}$$

$\cancel{V_B}$ —

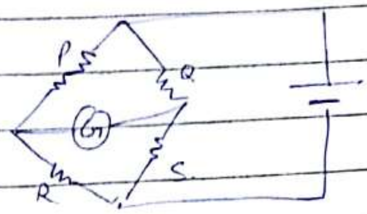
divide

$$\boxed{\frac{P}{Q} = \frac{R}{S}}$$

if position of galvanometer & battery are interchanged then null point remains unaffected (condi of zero deflection)



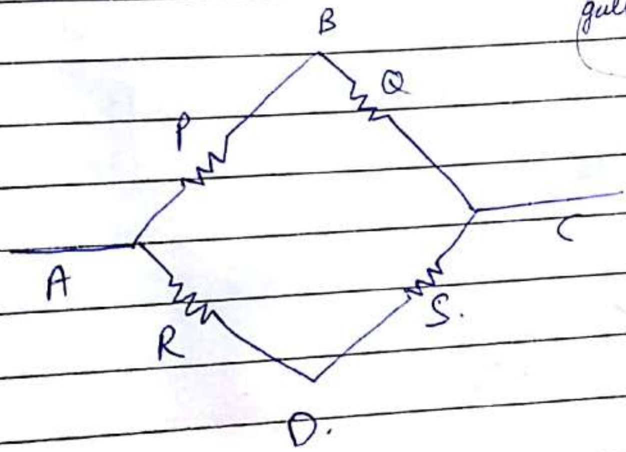
unaffected



$$\boxed{\frac{P}{Q} = \frac{R}{S}}$$

unaffected

For eq Calculation of Equivalent resistance across A & C

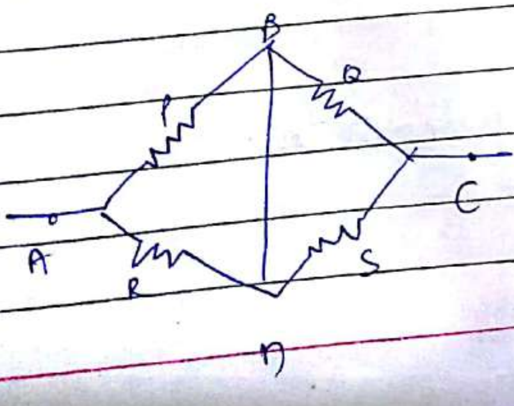


(galv is removed ya nhi bhi hotoye usse koi ~~to farak~~ Padta nhi)

they are in series

$$\frac{1}{R_{AC}} = \frac{1}{P+Q} + \frac{1}{R+S}$$

as B, D Potential Same. 0 resistance wire add kard

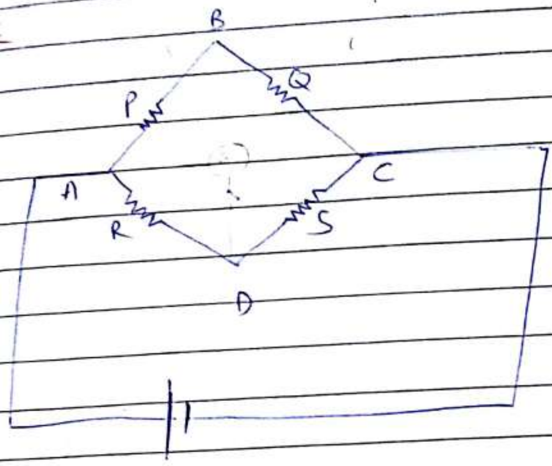


PR parallel, QS parallel.

add. then they are in series

$$R_{AC} = \frac{PR}{P+R} + \frac{Q \times S}{Q+S}$$

NOTE



~~if $V_B < V_D$~~ deflection hogi
& galvanometer added then D to B current flow hogi.

if $V_D > V_B$
current will flow from D to B

$V_A - V_D < V_A - V_B$

$V_{AD} =$

$\frac{V}{R+S} \cdot R < \frac{V}{P+Q} \cdot P$
(current) current i.e

$R(P+Q) < P(R+S)$

if $\boxed{PS > RQ}$ — ①

then current will flow from D to B — ③

then $V_B < V_D$ — ②

read ① ② ③

A को उठा के A' पे डाल दो diag ban jayga

icon

Date: / /

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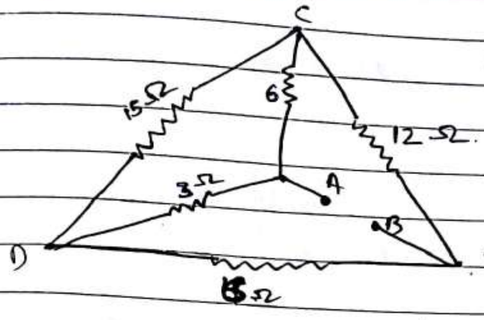
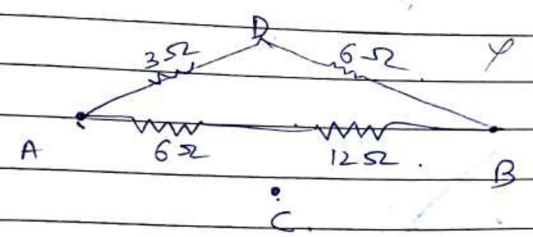
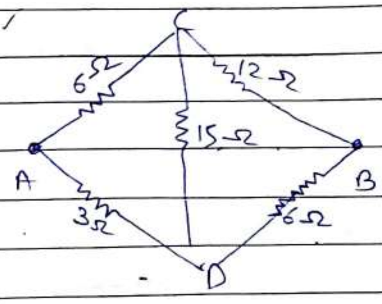
Q. Equivalent resistance across A & B







yes it is balanced wheat stone bridge

$$\frac{6}{3} = \frac{12}{6}$$

majority ①

$$\frac{1}{R_{AB}} = \frac{1}{6+12} + \frac{1}{3+6}$$

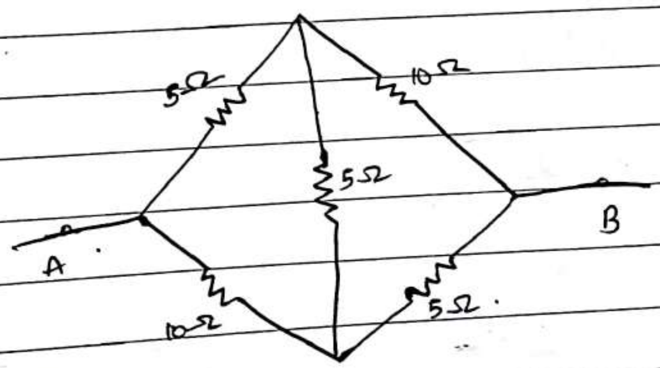
$$R_{AB} = 6\,\Omega$$

majority ② resistance wire lagake

or $\frac{6\times3}{6+3} + \frac{12\times6}{12+6}$

$= 6\,\Omega$

Q. find equivalent resistance across A & B



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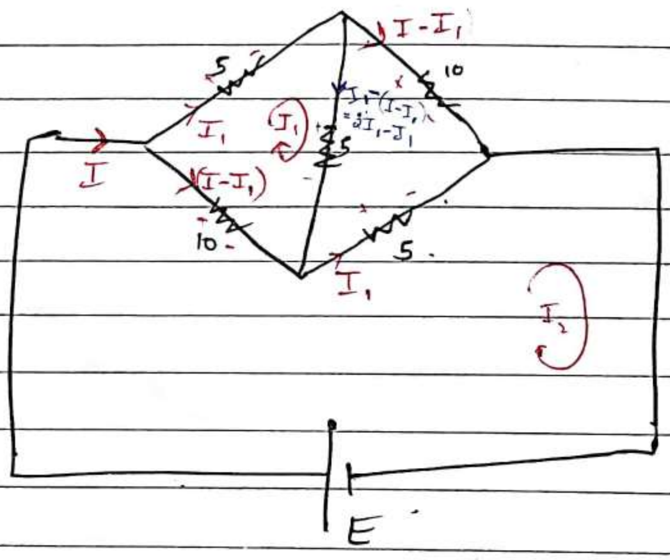
It is not wheatstone bridge
$5 \times 10 \neq 10 \times 5$.

current will from C → D if battery attached
we don't know abt which is series or in parallel

thus add a battery b/w A & B of EMF = E.



ab ye 2 loop
nhi ho rha
hi
he

$R_{eq} = \dfrac{E}{I}$

using KVL in loop ①

$$-5I_1 - 5(2I_1 - I_1) + 10(I - I_1) = 0 \quad \text{—— ①}$$

KVL in loop ②

$$-10(I - I_1) - 5I_1 + E = 0 \quad \text{—— ②}$$

from ① & ② $\frac{E}{I} = ?$ we get Req. thus 7Ω

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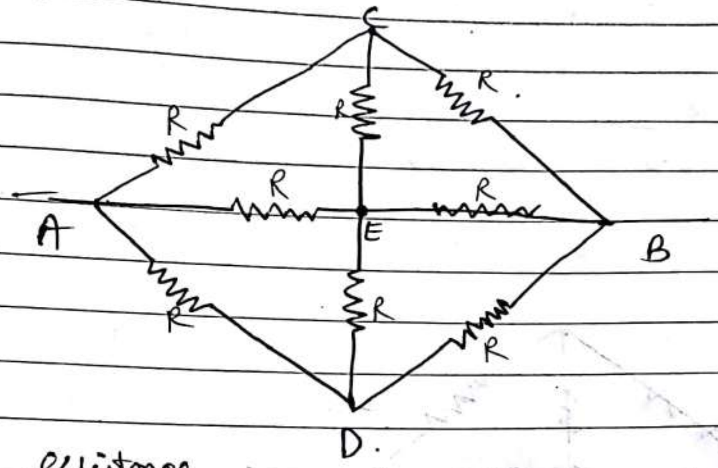
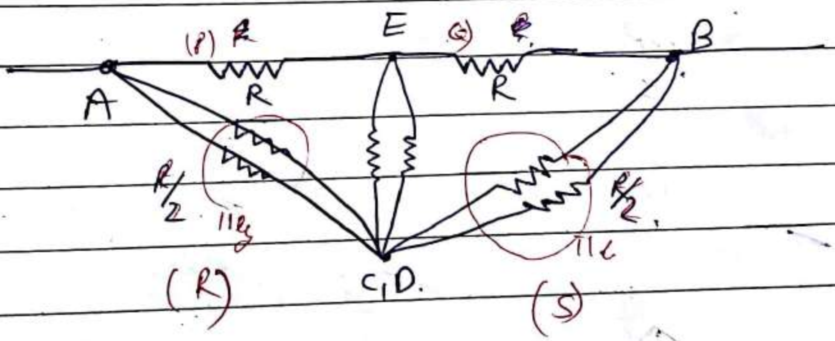
Calculation of equivalent resistance in symmetrical circuit



Equivalent resistance across A & B

$V_C = V_D$ — Hw ye dono alag alag nhi he ye ek hi he.



$\frac{(P)}{(Q)} = \frac{(R)}{(S)}$ $V_E = V_C = V_D$ thw bich el E.S nual taar bekar he

~~2R 2R~~ ~~$\frac{1}{2R} + \frac{2}{R} + \frac{2}{R}$~~ $\frac{1+4+4}{2R}$

Ex 2

DPP-21 CI → nowdalse (D_1 — D_7) Ex 1 Part I, Part II, Part III, Full Math $\frac{1}{2}$

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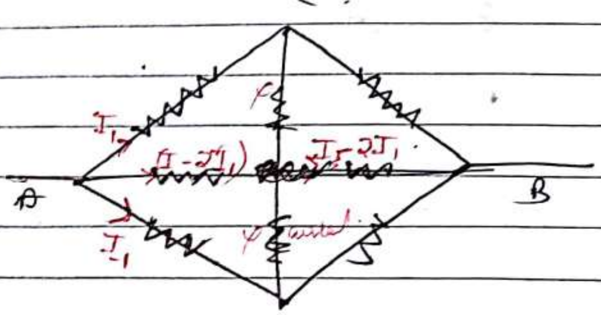
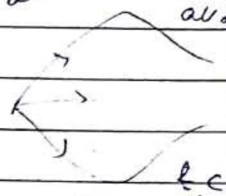
$$R = \frac{2R \cdot R}{2R + R} \qquad \frac{1}{R_{AB}} = \frac{1}{2R} + \frac{1}{R}$$

$$= \frac{2R}{3} \qquad R_{AB} = \frac{2R}{3}$$

najaria II



at end we knew that



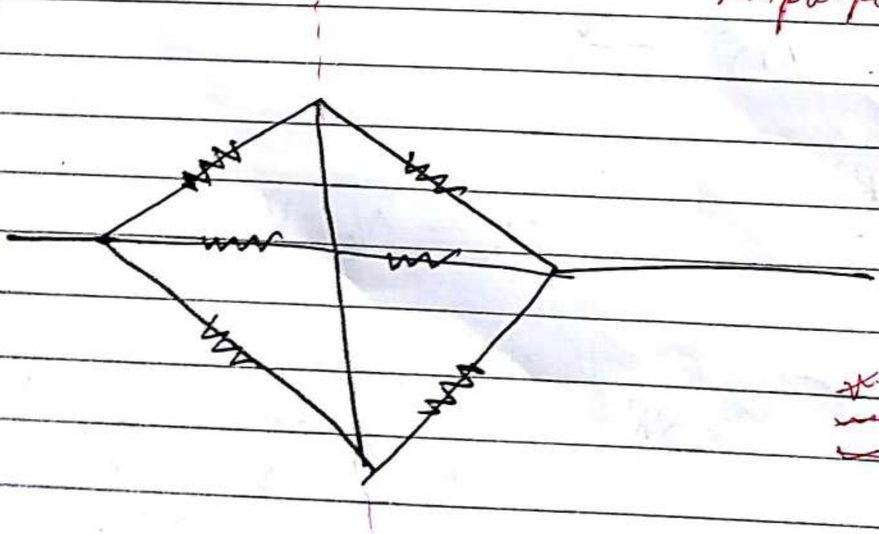
all three will have same current & CD bar is bekar.

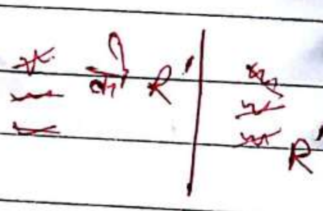
$$\frac{1}{R_{AB}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{2R}$$

$$= \frac{2R}{3}$$

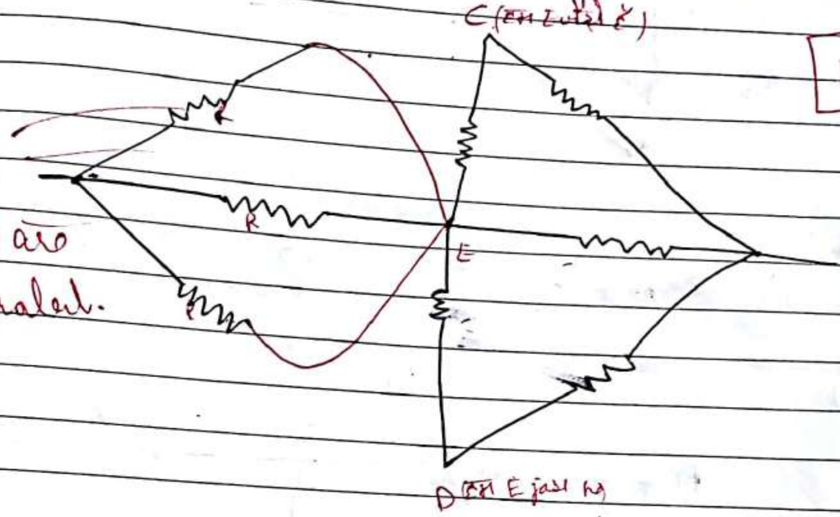
mirror img

najaria III   equipotentialline   Imp all potential same





mirror



now they are paralel.

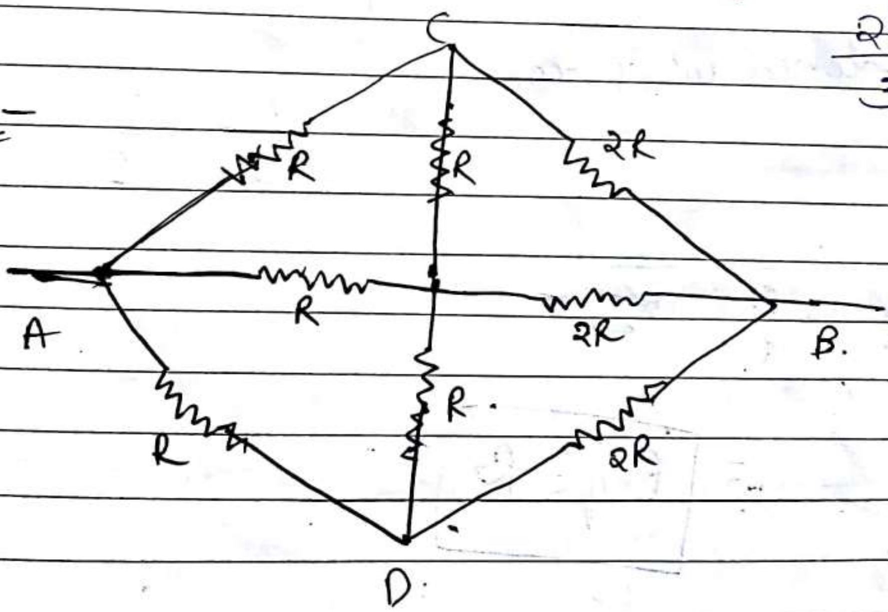
$$\boxed{R_{AB} = 2R'} \quad \text{—— (1)}$$

$$R' = \frac{R}{3} \quad \text{—— (2)}$$

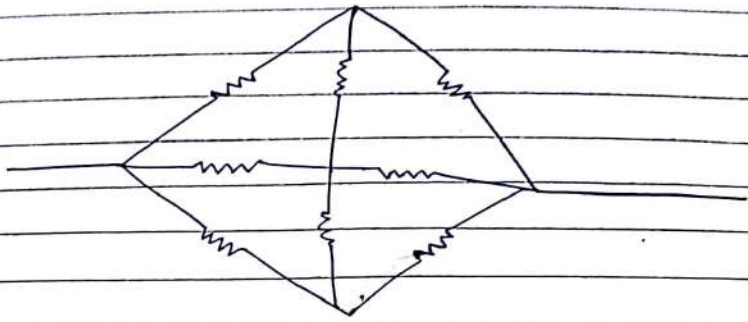
from (1) & (2)

$$\frac{2R}{3}.$$

Q-



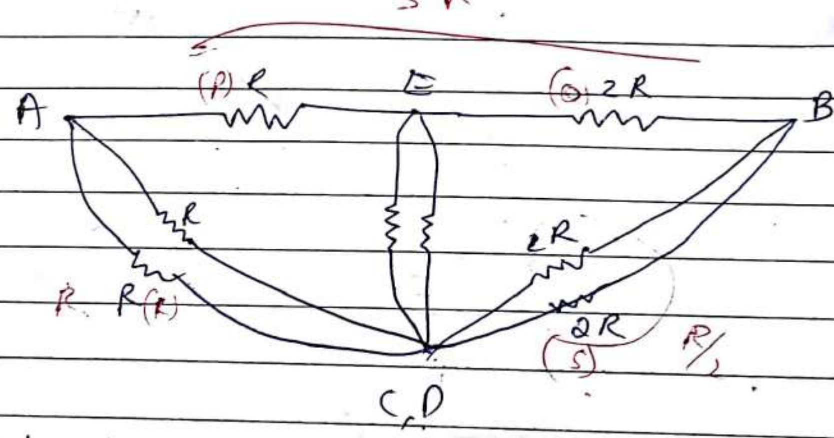
Calculate eq. resistance across A & B



Due to Symmetry.
Pt C & pt D same.

R-2R upar ek jaise
R-2R niche.

3R



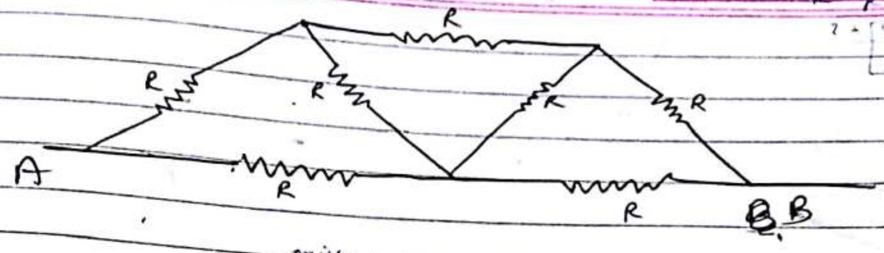
balanced wheat ston.

$$\frac{P}{Q} = \frac{R}{S}$$

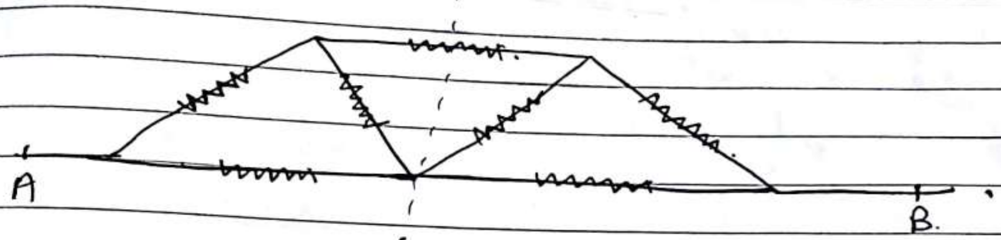
$$\frac{1}{R_{eq}} = \frac{1}{3R} + \frac{1}{3R/2}$$

$$= \boxed{R_{eq} = R}$$

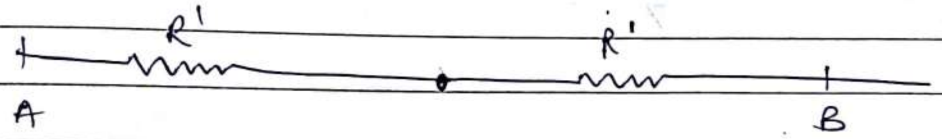
Q



mirror image

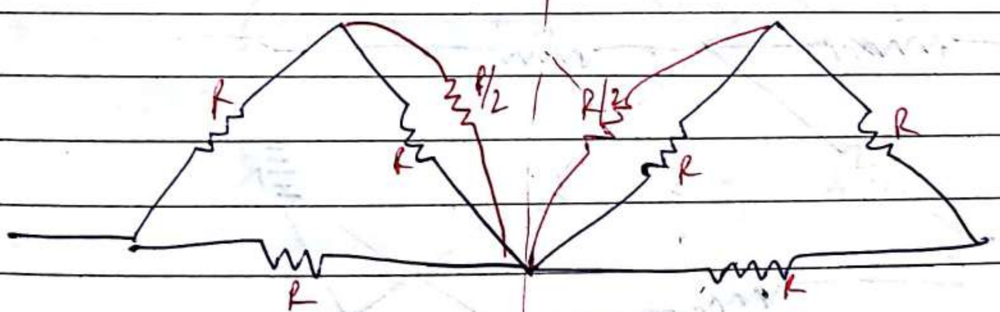


equipotential



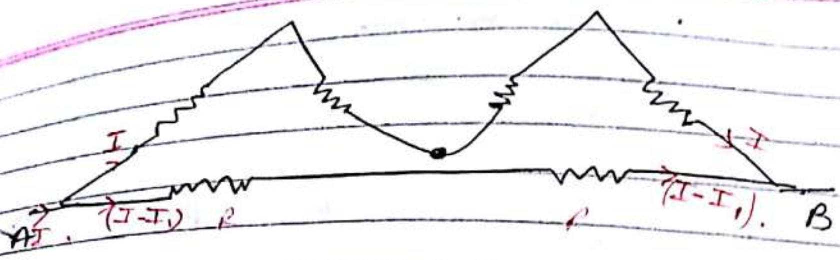
$R_{AB} = 2R'$

now to aim find R'



$$\frac{1}{R'} = \frac{1}{R} + \frac{1}{R+R/3} \Rightarrow R' = \frac{4R}{7}.$$

thus $R_{AB} = \frac{8R}{7}$



$$\frac{1}{R_{AV}} = \frac{1}{2R} + \frac{1}{\underbrace{2R}_{\text{left right}} + \underbrace{2R/3}_{\text{between}}}$$

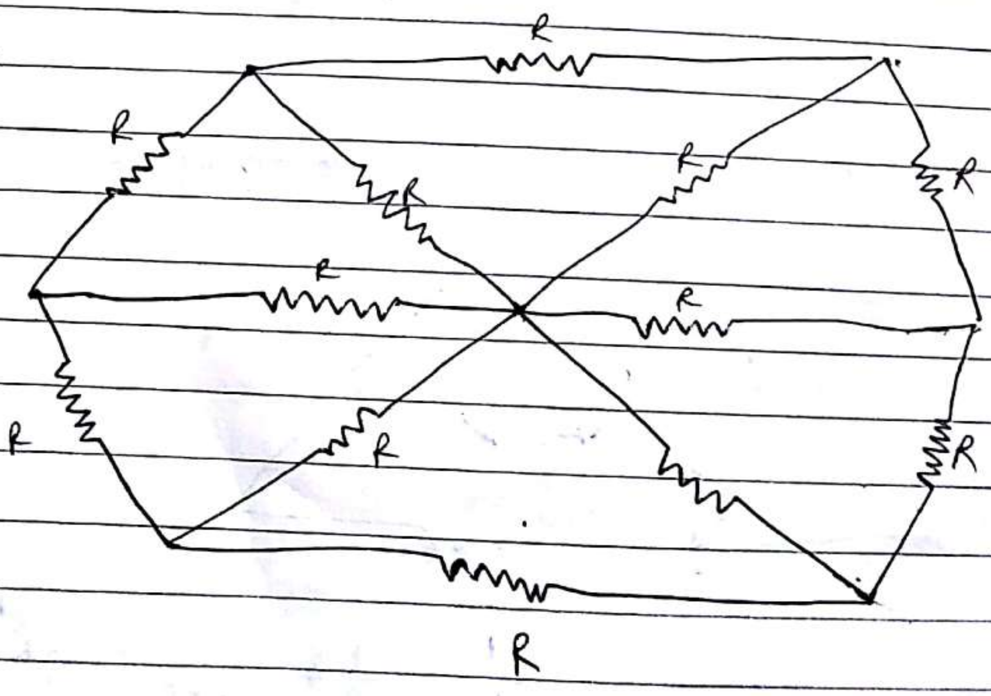
$$\frac{1}{2R} + \frac{1}{\frac{6R+2R}{3}} = \frac{1}{2R} + \frac{3}{8R}$$

$$\frac{4+3}{8R}$$

$$= \frac{7}{8R}.$$

$$\boxed{R_{AV} = \frac{8R}{7}}$$ Ans

Q:-



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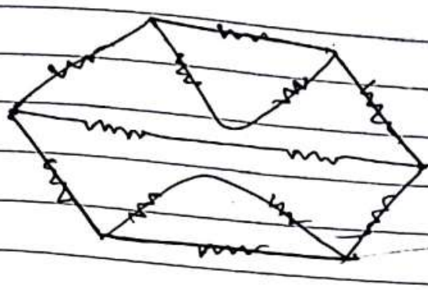
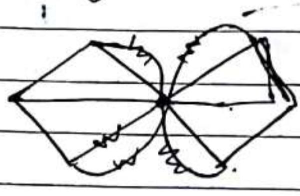


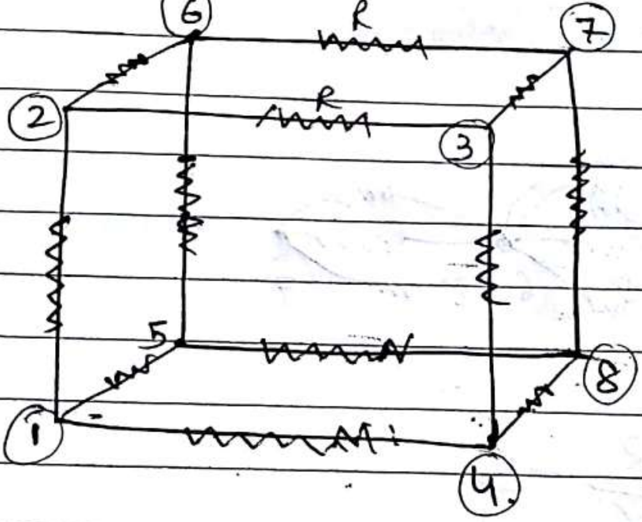
$$\frac{1}{R_{AV}} = \frac{2}{2R + 2R/3} + \frac{1}{2R}$$

$$= \frac{4R}{5}$$

or by connection removal meth



Q.



find equivalent resistance
1) across 1 & 7.
2) across 1 & 3
3) across 1 & 4

$$\boxed{\frac{8R}{3}}$$

$$\frac{1}{2R} + \frac{1}{R}$$

$$\frac{1+2}{2R} = \frac{3}{2R}$$

$$\frac{2R}{3} + R + R$$

8R

2R

$$\frac{8R}{3} = \frac{2R}{3} + \frac{2R}{3} = \frac{2R + 6R}{3}$$

$$\frac{6R + 2R}{3}$$

$\frac{\quad}{3}$

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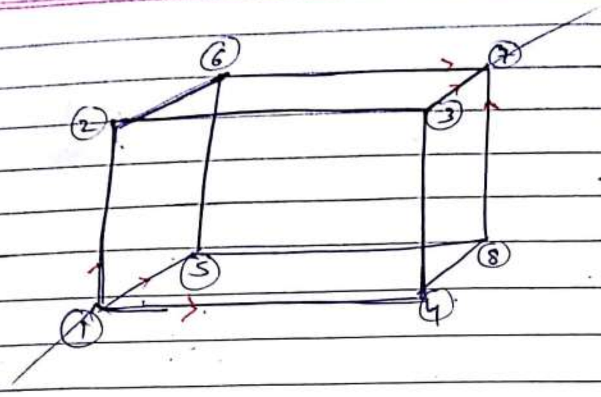
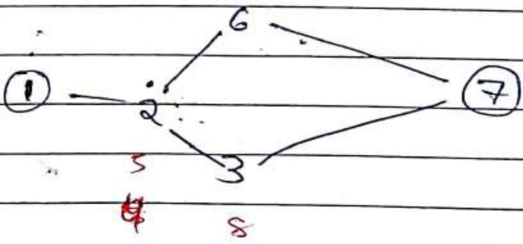
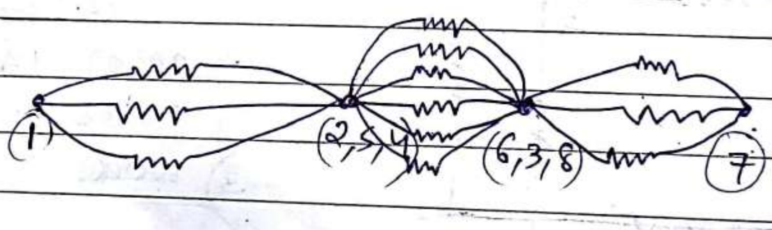




due to symmetry

2	6
5	3
4	8
potential same	potential same

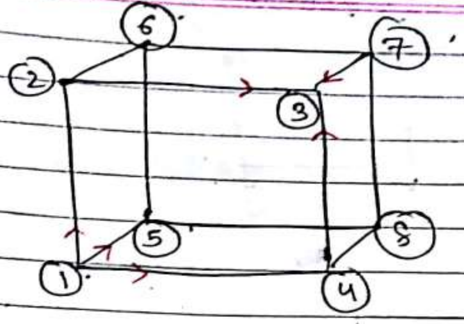
2, 5, 4 $\longrightarrow$ same potential
6, 3, 8 $\longrightarrow$ same potential



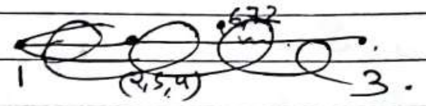
$$R_A = \frac{R}{3} + \frac{R}{6} + \frac{R}{3}$$

$$= \frac{5R}{6} \text{ Ans.}$$

2) 1 & 3.



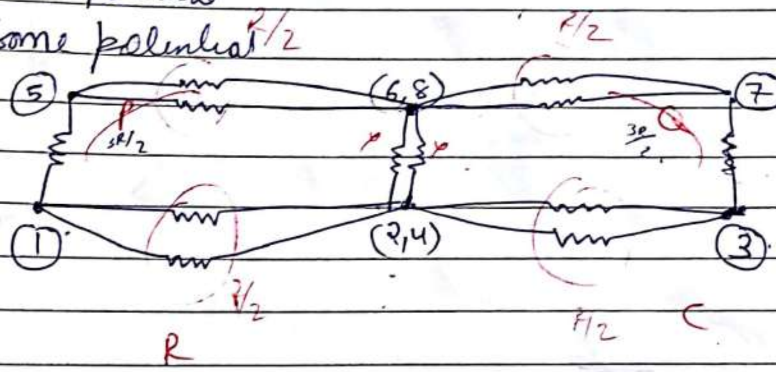
due to Sym.



2, 4 ⟶ same potential

6, 8 ⟶ same potential

re.



thr (2,6) & (4,8) के बीच में Taar
में no current flow.
(Faltu)

$$\frac{P}{Q} = \frac{R}{S}$$

balanced wheat stone bridge

$$R_{13} = \frac{3R \cdot R}{3R + R} = \frac{3R}{4} \text{ Ans}$$

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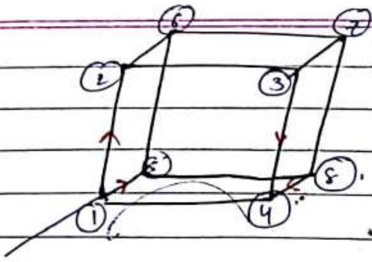
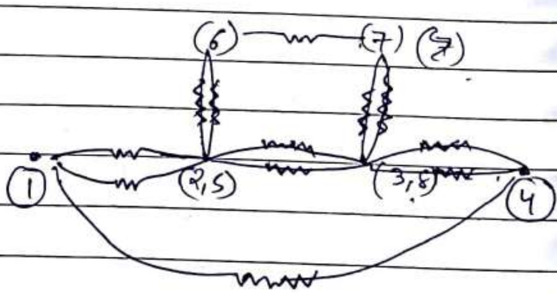
(Q3) 1,4



due to Sym,

2–5 Same potential
3–8 Same potential

4.



$$R_{14} = \frac{7R}{12}$$

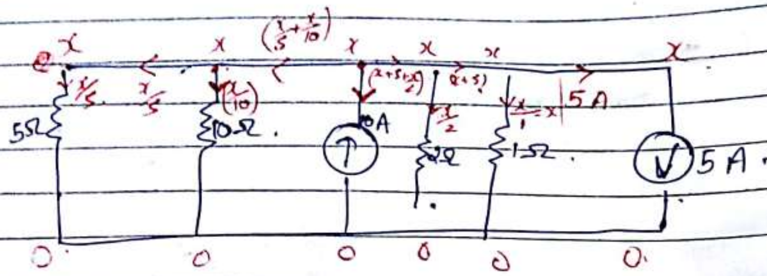
$R + C\frac{1}{R}$

$\frac{\frac{1}{R}+\frac{1}{R}}{2} + R + \frac{1}{R} + 1$

$\frac{1}{2R} + \frac{1}{R+R} \frac{1}{R} \quad \frac{R}{2} + R + \frac{2R}{2} \quad \frac{2}{R} + \frac{2}{R} + \frac{R}{1}$

$\frac{1+1}{2R} \quad \frac{12R}{D} \quad \frac{2R}{R}$

C-7



$$\frac{x}{5} + \frac{x}{10} + 10 + x + 5 + \frac{x}{2} = 0$$

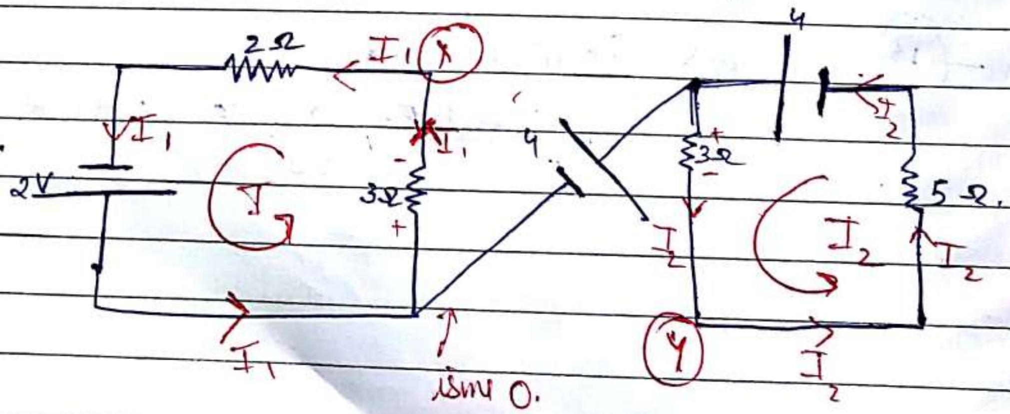
$$\frac{2x + x + 100 + 10x + 50 + 5x}{10} = 0$$

$15x + 110 = 0$ $18x + 150 = 0$

$x = -\frac{150}{18} = -\frac{25}{3}$

C-10 $V_S = V_A - V_B$ & yhã battery band

D-6



$$I_1 = \frac{2}{2+3} \qquad I_2 = \frac{4}{3+5}$$

$$V_x + 3I_1 + 4 - 3I_2 = V_y$$

$$V_x - V_y = 3I_2 - 3I_1 - 4$$

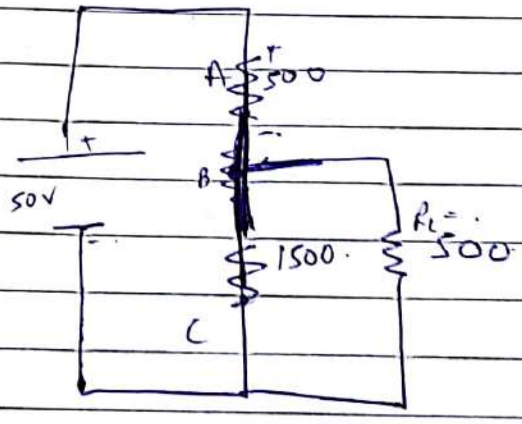
$$3\frac{1}{2} - 3\frac{2}{5} - 4 \qquad \frac{3}{2} - \frac{6}{5} - \frac{4}{1}$$

$$\frac{15 - 12 - 40}{10}$$

$$= \frac{-37}{10}$$

no affect b/c bich wale me koi current nhi he.
indepen of internal resistance

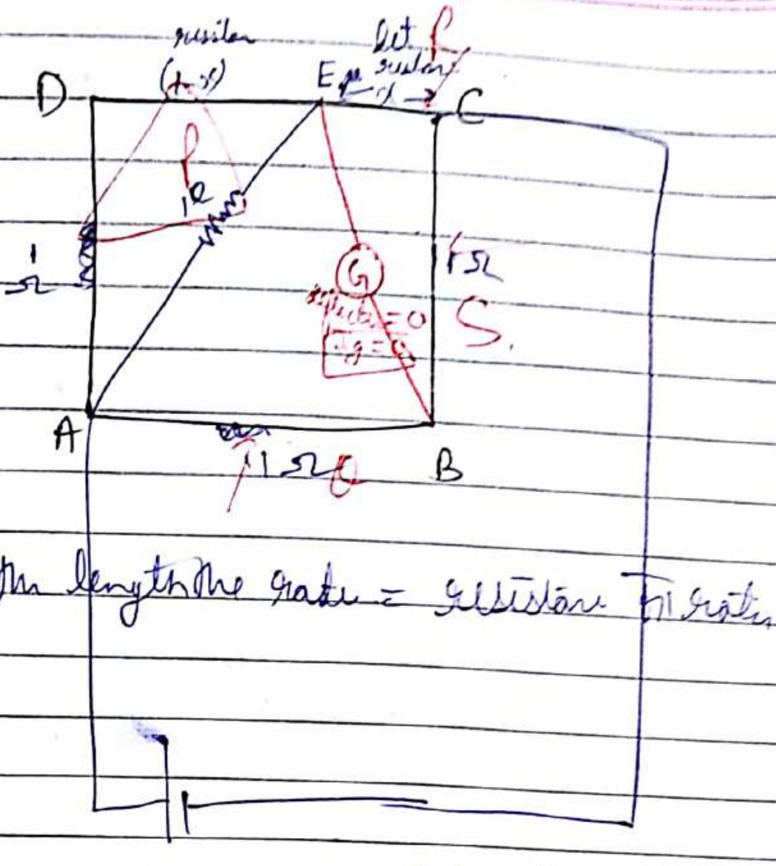
D-9 - AC = 2000 Full: 500
∴ BC = 1500



$$I = \frac{50}{500 + \frac{1500 \times 500}{1500 + 500}}$$

then $V_1 + V_2 = V$

10)



the length ki ratio = resistance ki ratio

E, B same potential.

$$P = \frac{2-x}{2-x+1} = \frac{\frac{2-x}{3-x}}{1} \qquad \frac{P}{Q} = \frac{R}{S}$$

$$\frac{\frac{2-x}{3-x}}{1} = \frac{x}{1}$$

$$\frac{x-2}{x-3} = x$$

$$x^2 - 3x = x - 2$$

$$(x-2) = x(x-3)$$

$$x = \ldots$$

$$\frac{CE}{ED} = \frac{x}{(1-x)}$$

length ki resistance ki ratio hai

icon

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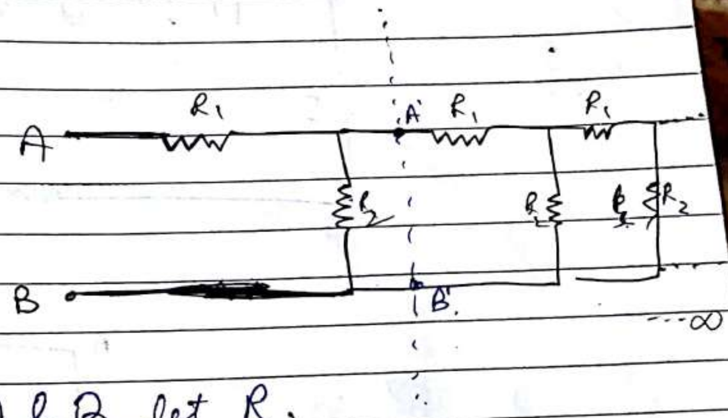
Combination of cell

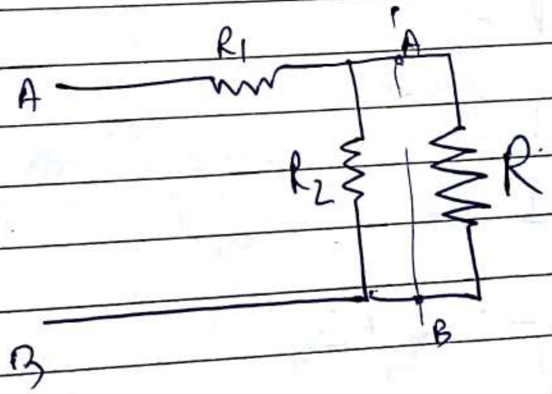
Infinite network



equivalent across A & B let R.

from A' B' its also R.

The



$$\boxed{\frac{R_2 R}{R_2 + R} + R_1 = R}$$

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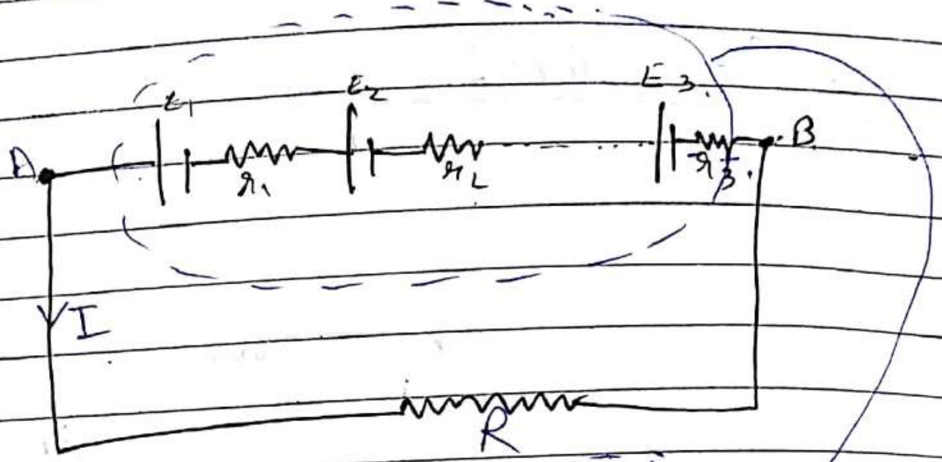
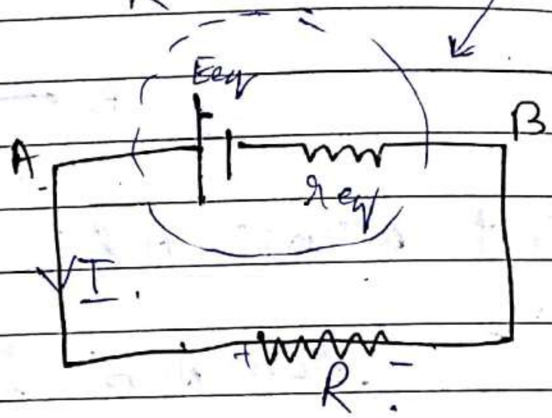
Comination of cells.

Series -





$$\boxed{I = \frac{E_{eq}}{R + r_{eq}}} \qquad \frac{E_{eq}}{\text{total resistance}} \text{ --- (1)}$$

using KVL in fig (a)

$$-IR - IR_n + E_n \ldots$$

$$\boxed{I = \frac{E_1 + E_2 + \cdots E_n}{R + R_1 + R_2 + \cdots R_n}} \text{ --- (2)}$$

$$\boxed{E_{eq} = E_1 + E_2 + E_3 + \dots E_n}$$ with polarity

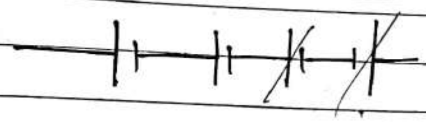
$$R_{eq} = \cancel{R_1} + \cancel{R_2} + \cancel{R_3} + \dots R_n.$$

$r_1 \quad r_2 \quad r_3$

if $E_1 = E_2 = \dots\dots = E$

& $r_1 = r_2 = \dots\dots = r$.

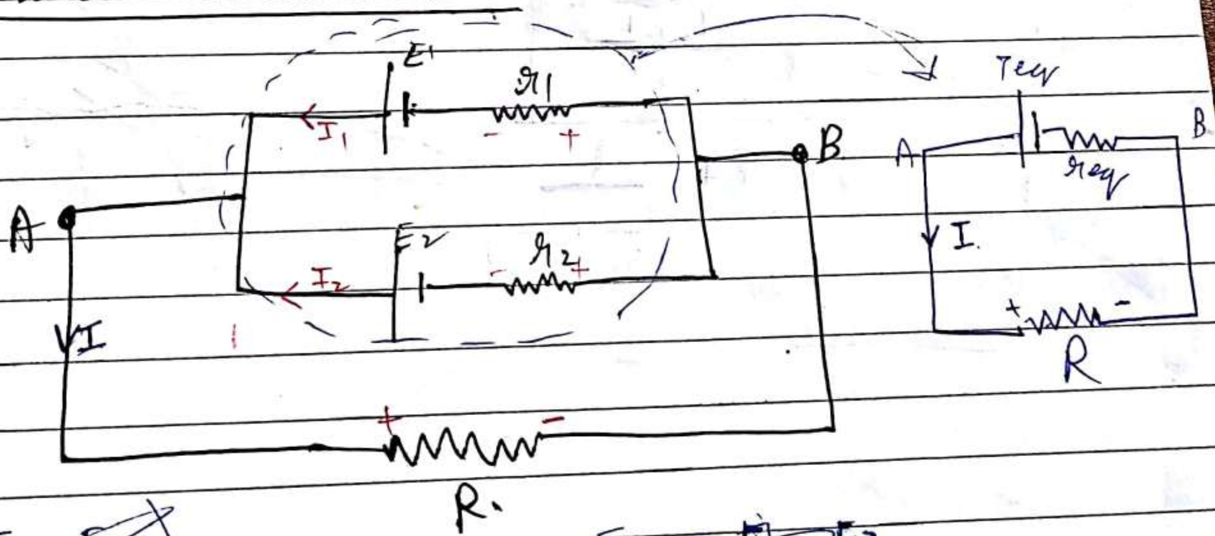
$$\boxed{I_{eq} = \frac{nE}{R + nr}}$$



→ if m cells are connected with opposite polarity then.

$$I = \frac{(n-2m)E}{R + nr}$$

Parallel Combination



$$\cancel{\frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{R + \left(\frac{1}{r_1} + \frac{1}{r_2}\right)}}$$

$$E_{eq} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$$

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$$\boxed{I = \frac{E_{eq}}{R + r_{eq}}} \quad (1)$$

$E_1 - I_1 r_1 = IR$ and $E_2 - I_2 r_2 = IR$

$$\boxed{I = I_1 + I_2}$$

$$I = \frac{E_1 - IR}{r_1} + \frac{E_2 - IR}{r_2}$$

$$I = \frac{r_2(E_1 - IR) + r_1(E_2 - IR)}{r_1 r_2}$$

$$I = \frac{E_1}{r_1} - \frac{IR}{r_1} + \frac{E_2}{r_2} - \frac{IR}{r_2}$$

$$I\left[1 + \frac{R}{R_1} + \frac{R}{r_2}\right] = \frac{E_1}{r_1} + \frac{E_2}{r_2}$$

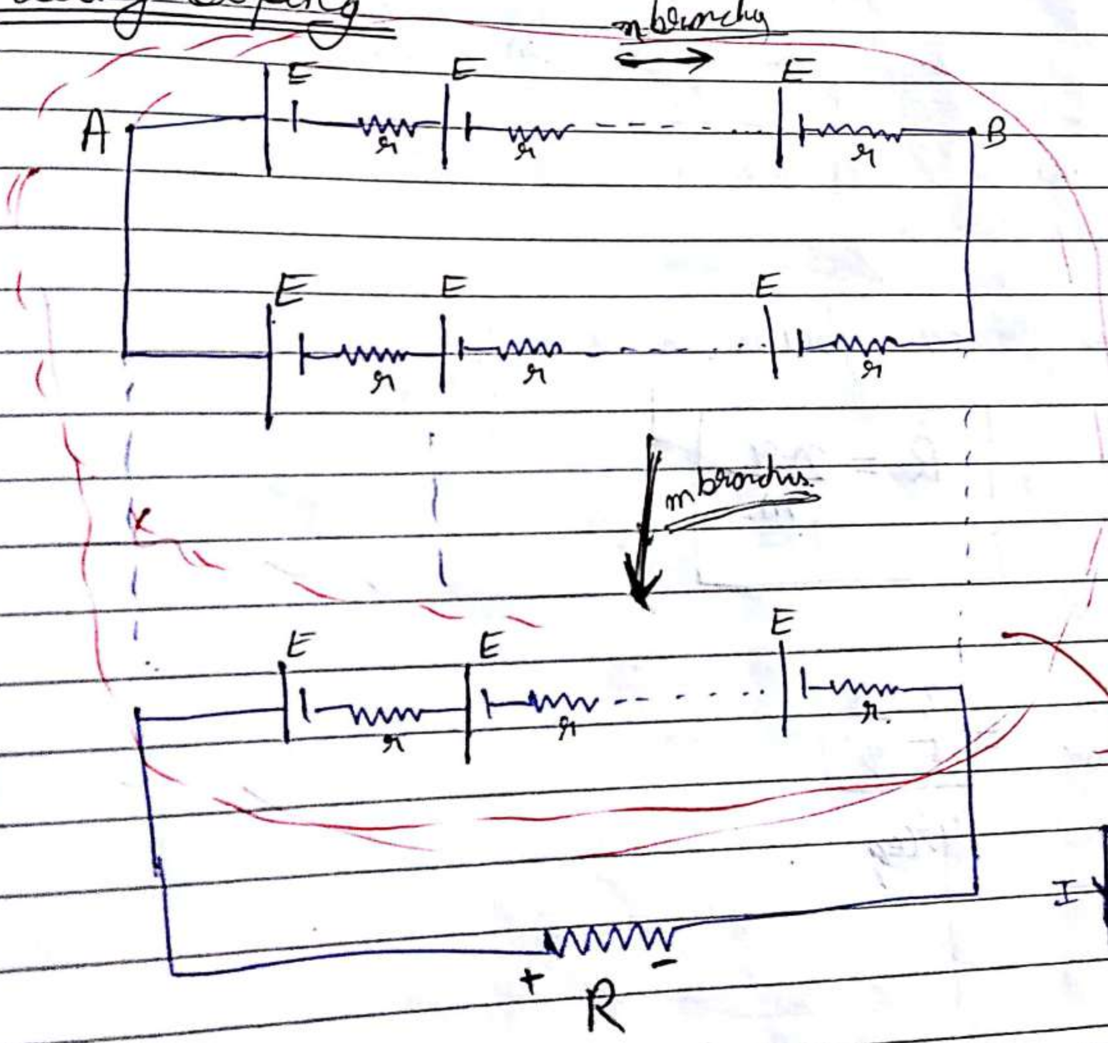
$$\boxed{I = \frac{\left\{\dfrac{\dfrac{E_1}{r_1} + \dfrac{E_2}{r_2}}{\dfrac{1}{r_1} + \dfrac{1}{r_2}}\right\}}{R + \dfrac{1}{\left(\dfrac{1}{r_1} + \dfrac{1}{r_2}\right)}}} \quad (2)$$

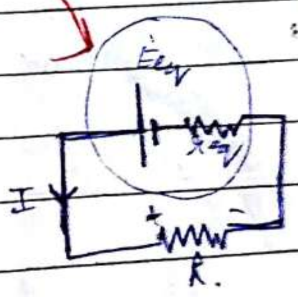
$$E_{eq} = \frac{\left(\frac{E_1}{r_1} + \frac{E_2}{r_2}\right)}{\frac{1}{r_1} + \frac{1}{r_2}}$$

put E_1 & E_2 with polarity

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$$

Mixed grouping





$$I = \frac{E_{eq}}{R + r_{eq}}$$

equivalent e. nE

equivalent Emf $= mE$

$E_{eq} = nE$

$r_{eq} = \frac{nr}{m}$

$$\boxed{I = \frac{nE}{\left(R + \frac{nR}{M}\right)}}$$

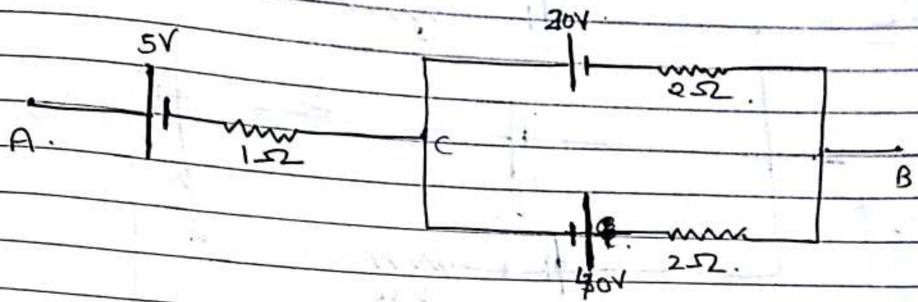
total no of cells m.n.

for max. power in load R.

$$\boxed{R = \frac{nr}{m}}$$

$$P_{max} = \frac{E_{eq}^2}{4r_{eq}}$$

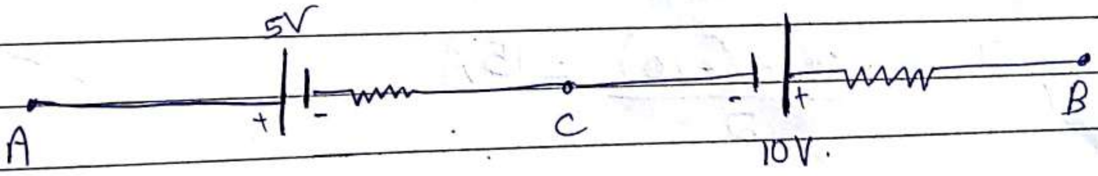
Q.

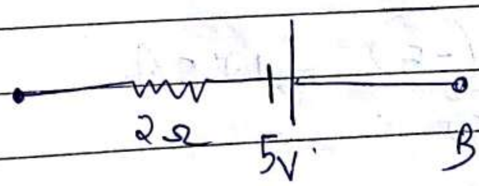


find E_{eq} & r_{eq}.

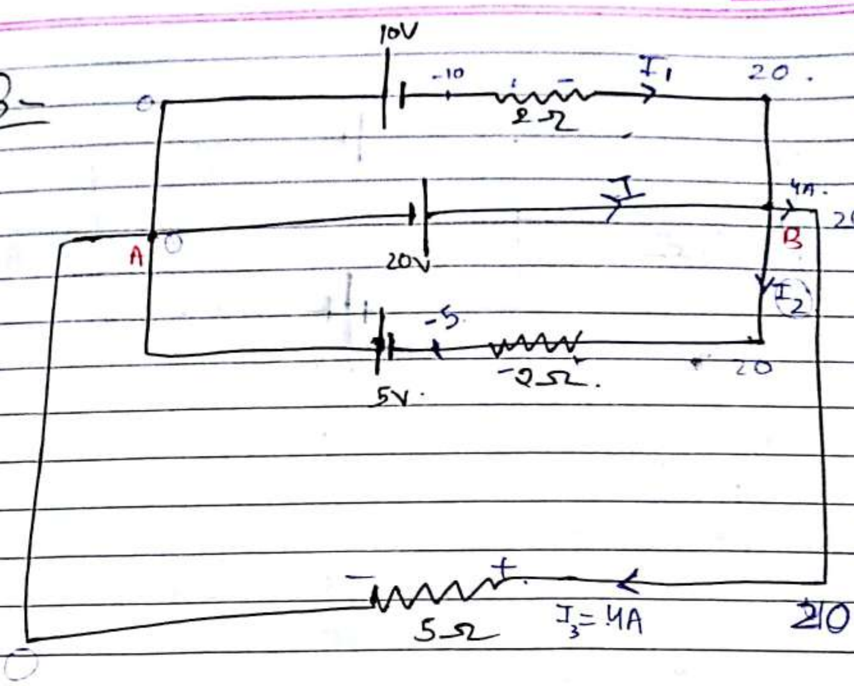
$$E_1 = \frac{\frac{40}{2} - \frac{20}{2}}{\frac{1}{2} + \frac{1}{2}}$$

$= 10V$





Q-



Calculate 1) current flowing in 5Ω resistance.
2) current flowing through branch of 20 V battery

Eq = . ideal AB potential diff 20
AB . potential ''
AB '' . ''

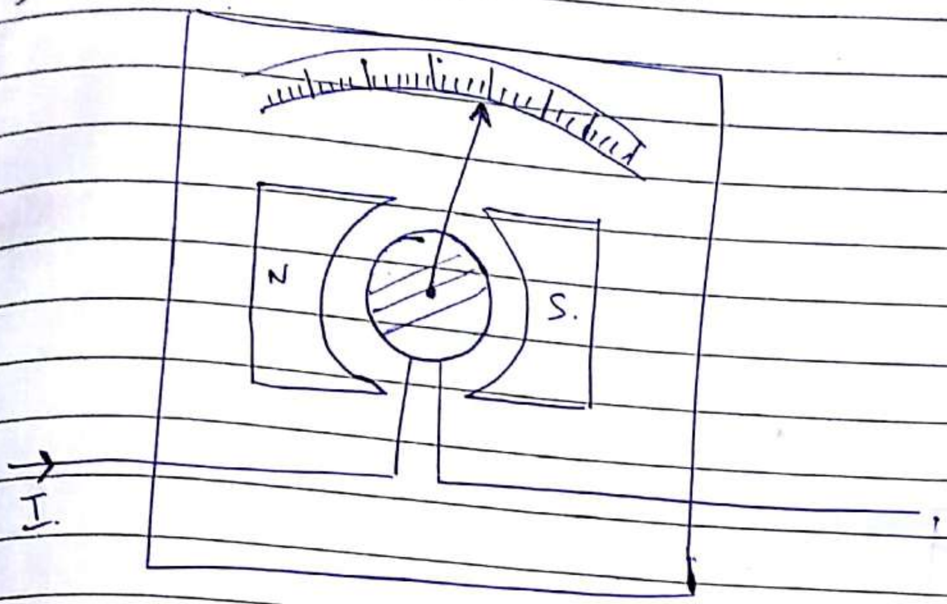
$$I_1 = \frac{20-(-10)}{2} = 15A$$

$$I_2 = \frac{20-(-5)}{2} = 12.5A.$$

$$\boxed{I = I_1 + I_2 + I_3} = 15 + 12.5 + 4 \text{ Ans}$$

Electric instruments

1) Galvanometer



Due to magnetic field
torque on MF.

$$\boxed{\tau_{\text{Magnetic field}} = BINA}$$

magnetic field · current · no of ~~...~~ turns · area of coil

$$\vec{\tau} = \vec{P} \times \vec{E} \qquad \vec{\tau} = \vec{M} \times \vec{E}$$

$$\boxed{M = NIA}$$

magnetic dipole moment

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$\tau_{spring} = C\phi$

$C \rightarrow$ torsional const
$\phi \rightarrow$ angle of deflection

<u>at equilibrium</u>

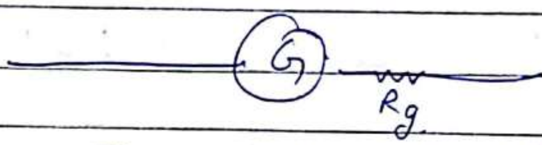
$\tau_{spring} = \tau_{magnetic\ field}$

$C\phi = BINA$

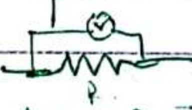
$$\boxed{\phi = \frac{BNA}{C} \cdot I}$$

$\phi \propto I$

angle of deflection $\propto$ current

it is represented as 

$I_g \rightarrow$ full scale deflection current.

- Ammeter is always connected in series with element we want to measure if parallel then it will blow up
- Ammeter has very less resistance so it don't disturb the current & Voltmeter is connected in parallel as we want to measure whole voltage b/w an resis  but 

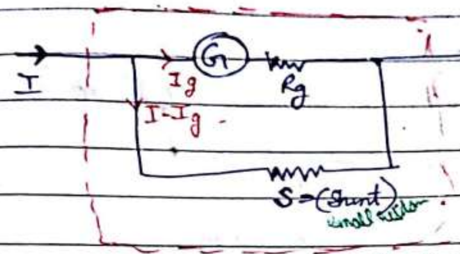
& as voltmeter is connected in ll it has a very large Resistance

SOCE HW

→ galvanometer ~~Godt~~ – batana ki current hai ki nhi
→ ammeter Calculate karna kitna

Ammeter –

$I \rightarrow$ range of ammeter (max current can be measured)



as they in ||

voltage of across Rg & S is equal

$$I_g R_g = (I - I_g) S$$

$$\boxed{S = \frac{I_g R_g}{(I - I_g)}}$$

$$\& \frac{1}{R_{effect}} = \frac{1}{R_g} + \frac{1}{S}$$

A Ra. = Resistance of ammeter

eq resistance of shunt & galvanometer

$$R_A = \frac{R_g \times S}{R_g + S}$$

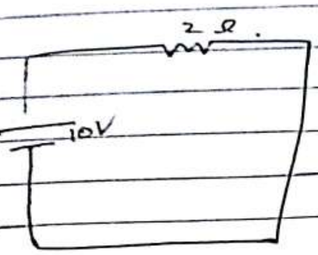
$$2 = \frac{I}{0.015 + R}$$

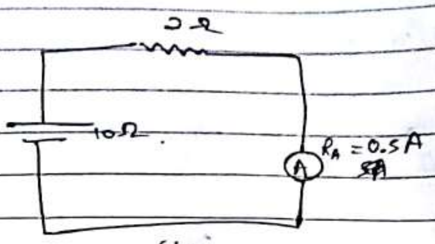
if $R_g >> S$

$$\boxed{R_A \approx S}$$

To measure the current (A) is connected with series in that branch

Eg:-



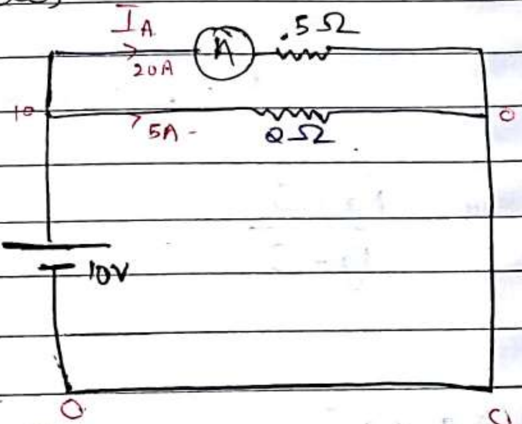


$\frac{10}{2} \cdot (5) A$ $\frac{10}{2+0.5} = 4A$

5 change in current

Thus we can get toward reading by take resistance of Ammeter = 0.

Q find reading of Ammeter.



$\frac{10}{2.5}$

In ameter

$= \frac{10}{0.5} = 20$

$I_A = \frac{10-0}{.5} = 20A$ only in that branch

note – in an electric circuit —Ⓐ— is treated as resistor

$V = I_g(R_g+R)$

$\frac{V}{I_g} - R_g$

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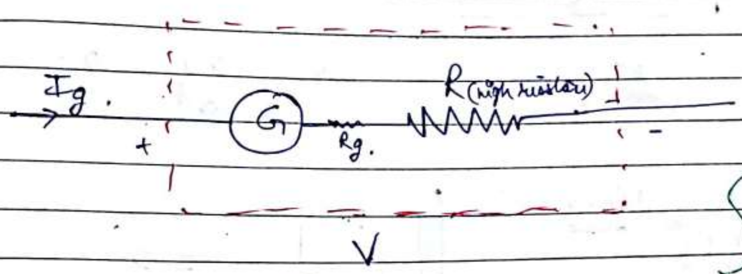
Voltmeter

It measure potential difference across any two point in electrical circuit.



- V → range of voltmeter
- R → high resistance
- R_g → galvano resistance

high resistance is connected with (G) in series to make it Voltmeter

$$V = I_g(R_g + R)$$

$$\boxed{R = \frac{V}{I_g} - R_g}$$

to calculate potential diff (V) is connected in ||

repar

$\boxed{R_V = R_g + R}$

$R_V = R$ if $R_g << R$

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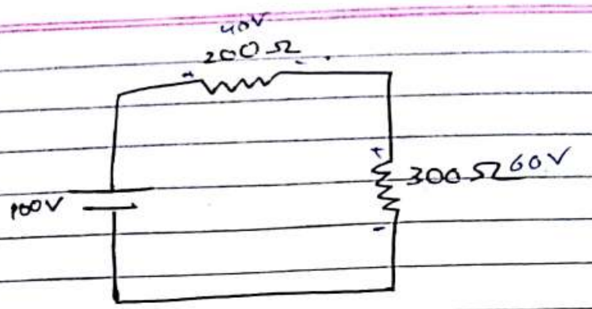
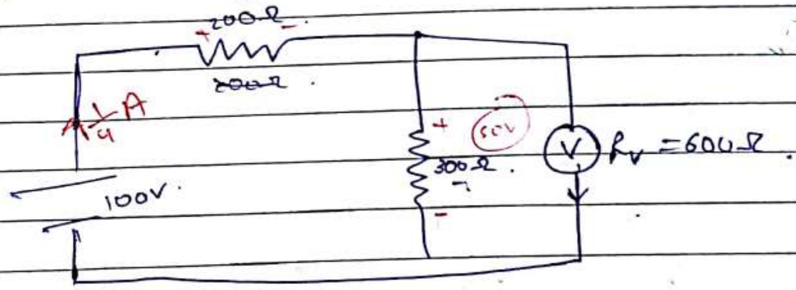
$50 \quad 200 \quad \frac{1}{100} = 1 \times 500$



$V = IR$. $\quad \frac{100}{500} = I$ $\quad$ $V = \frac{100}{500} \times 300 = 60$

IR



70 fut at 300

$\boxed{\text{reading of voltmeter = Potential diff across terminals of voltmeter}}$

& V is conn in ∥ but resist in series m/parallel

$$\frac{1}{300} + \frac{1}{600} = \frac{2+1}{600} \quad \frac{3}{600} = 200$$

now they are series

400Ω.

$V = IR$

$\frac{100}{400} = I$

we got 50

but from prev it was 60.

50.

$\frac{1}{4} \times 600 \quad \frac{1}{4} \times 600 \quad 150$

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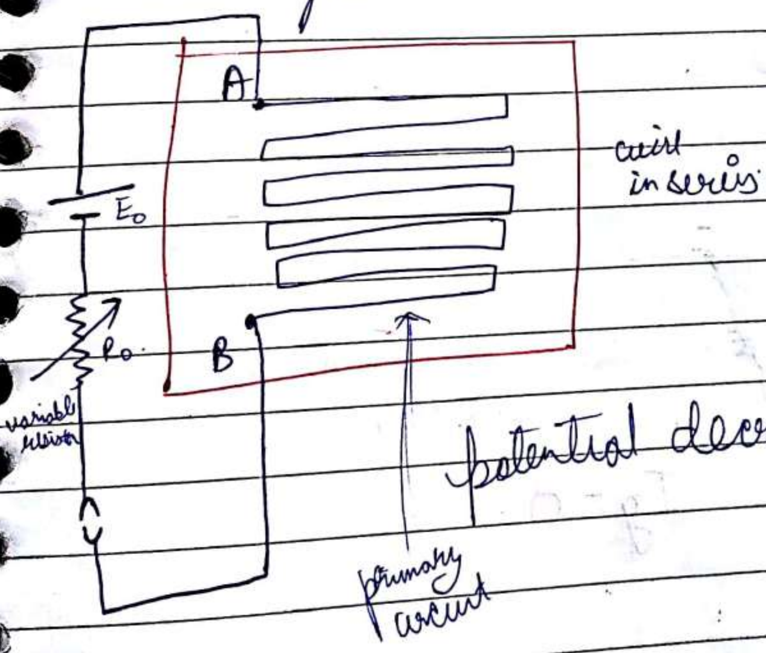
volt... consumed a little current.
thu vnse consume karke. current change kardia usse hone wale consequence ko read kiya thu —(V)— galt nhi tha

if we want exact reading
thus it should be ideal i.e. resistance of -(V)- is ∞
then it doesn't withdraw current

in a circuit voltmeter is treated as resistor.

Potentiometer (ideal voltmeter jaisa hota hai)

It measure potential difference across any two point in circuit.



uniform wire AB length-L
resistance = R

potential decreases uniformly b/c wire uniform

$\frac{V}{VF+CP}$

current $\boxed{I_0 = \frac{E_0}{E+R_0}}$

poten diff across potentio wire.

$$V_A - V_B = I_0 R$$

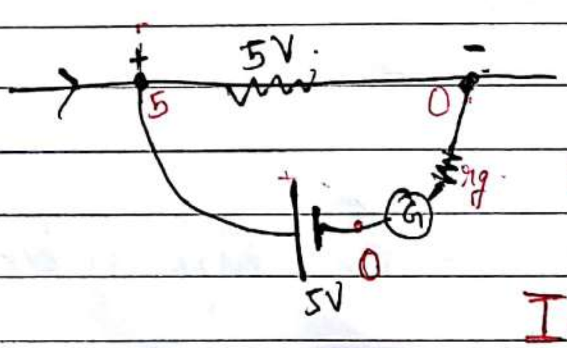
$$\left(\frac{E_0}{E+R_0}\right)R$$

potential gradient -

change in potential per unit length.

$$\boxed{K = \frac{V_A - V_B}{l}}$$

Concept



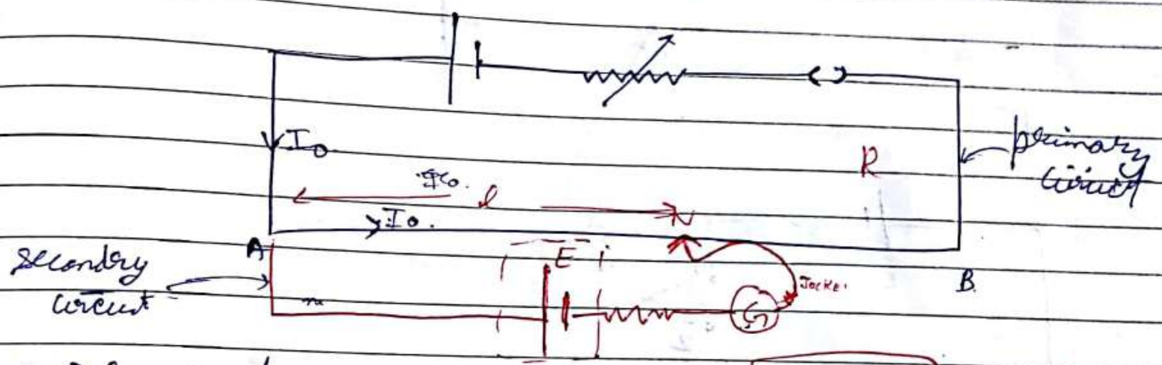
this situation when current = 0

$I_g = 0$

Standardisation

~~pole~~ the process of finding potential gradiant of potentiometer wire with the help of cell of ~~known~~ known emf

Circuit diag



(+ve) terminis of standard cell conn'

$\boxed{I_g = 0}$ होता है तो
null point

when null pt is obtaind when current in (G) branch become 0
dis of null pt is l.

$\boxed{\text{now potential across A \& N is the emf of standard cell}}$

per unit length K change
(total) change Kl

$$\boxed{E = Kl}$$

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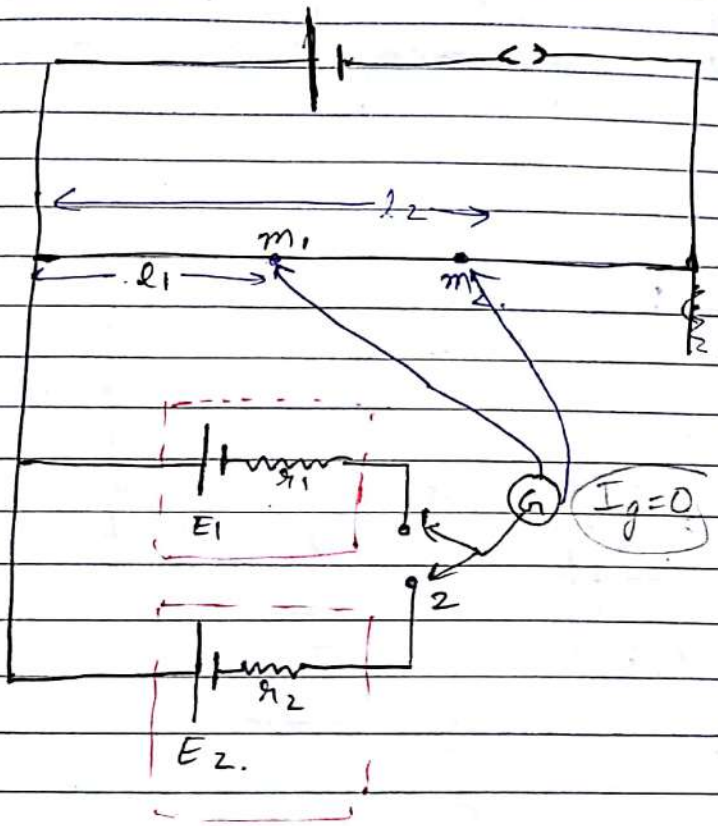
Comparison of emf of two Cells

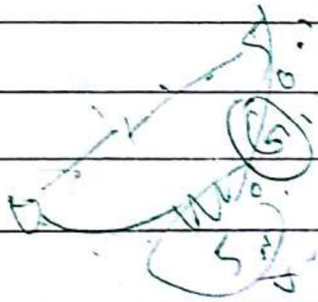


position · 1

$$E_1 = kl_1$$

$$E_2 = kl_2$$

$$\boxed{\frac{E_1}{E_2} = \frac{l_1}{l_2}}$$



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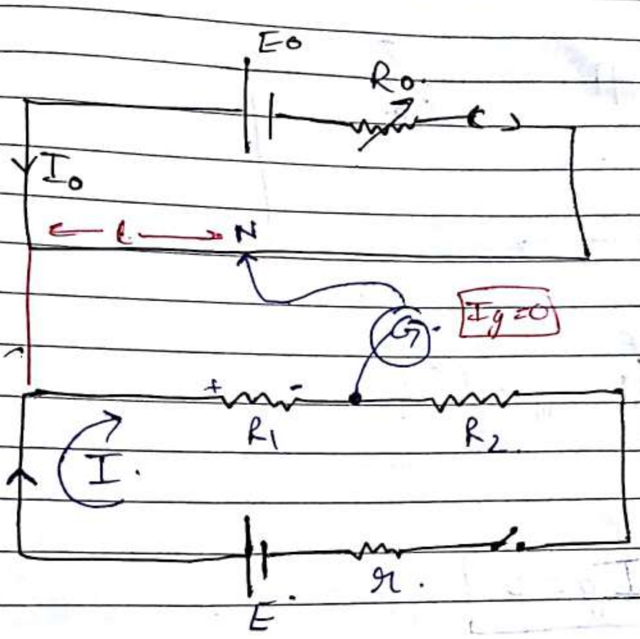
Calculation of current in a resistance if its resistance is known



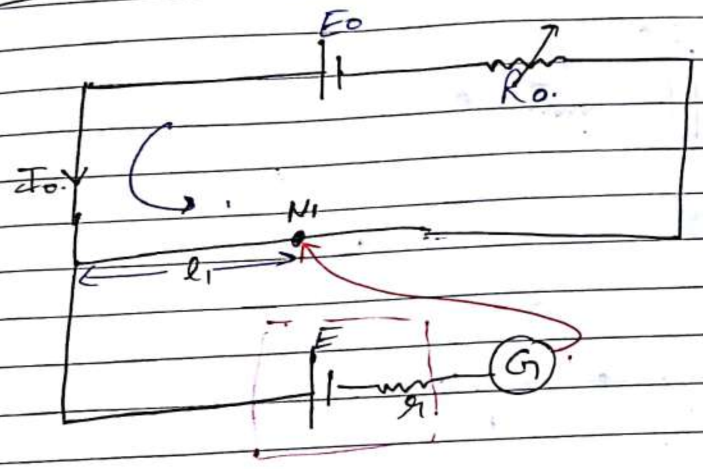
null point $\boxed{I_g = 0}$

pot diff across R_1 = pot diff across A & B

$$IR_1 = Kl$$

$$I = \frac{Kl}{R_1}$$

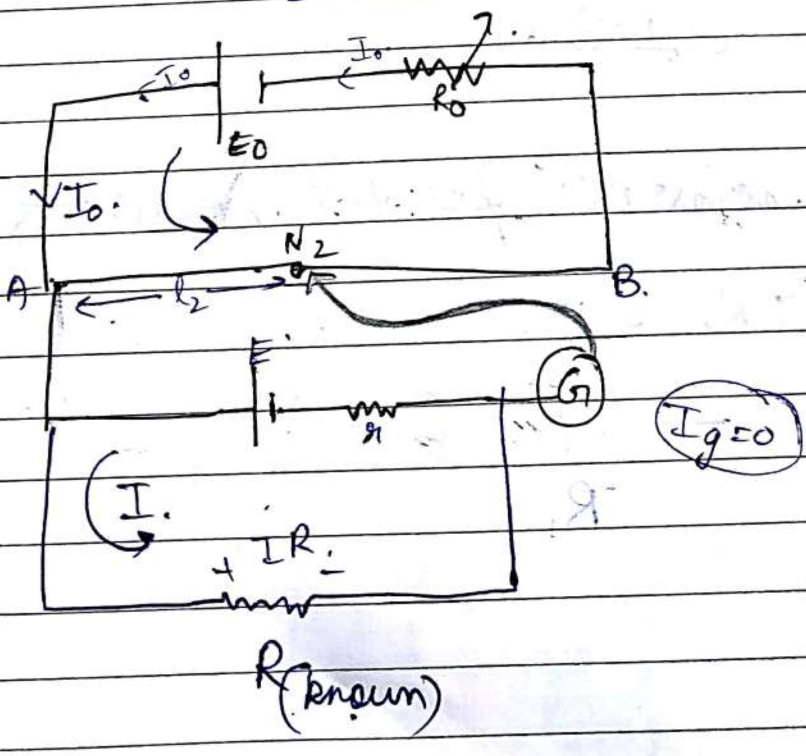
Calculation of internal resistance of a Cell



null point

$$\boxed{I_g = 0}$$

$E = kl_1$ —— (1)



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$\because V_{AJ} = IR = K l_2$

$$\left(\frac{E}{r+R}\right) R = K l_2 \quad \text{--- (2)}$$

Solving eq (1) & (2)

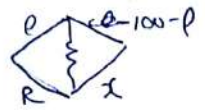
$$\boxed{r = \frac{(l_1 - l_2)}{l_2} R}$$

internal resistance

max Pot Diff which can ~~length~~ be measured by potentiometer wire is the potential diff across potentiometer wire.

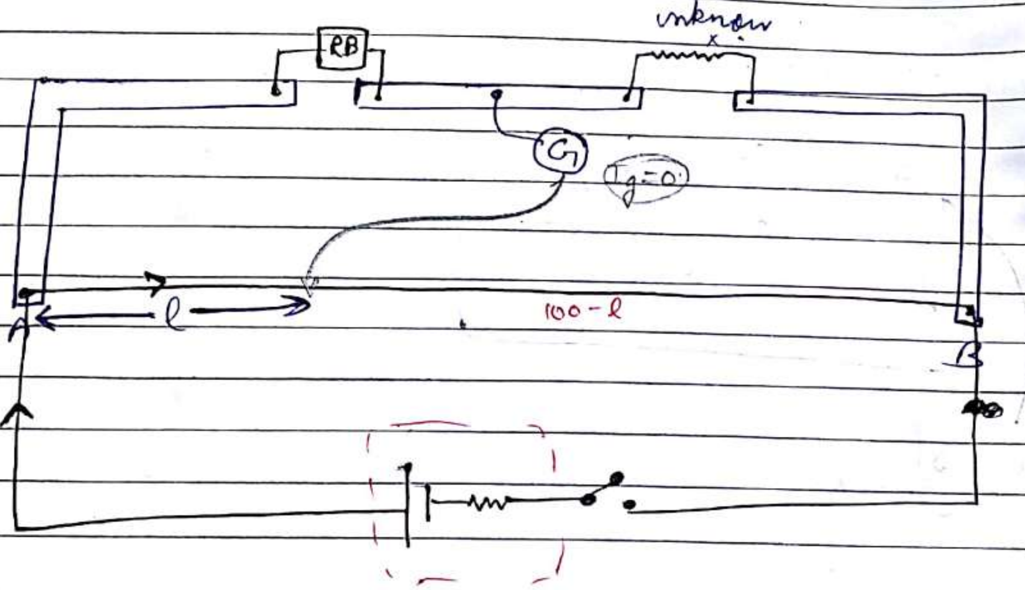
AB → max potential

potentiometer does not draw any current from secondary circuit while measuring potential diff. thats why its known as ideal.

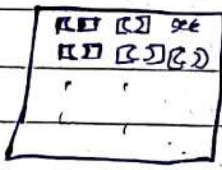


Meter bridge.

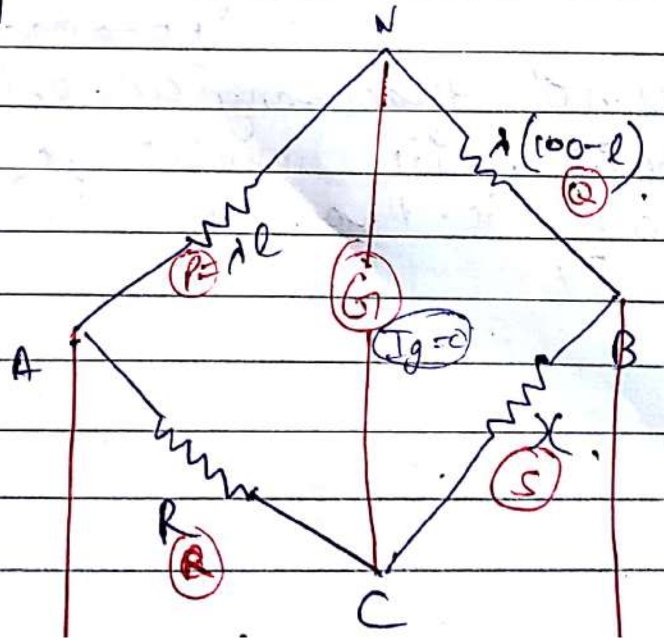
It has 1m long wire and works on the principle of wheat stone bridge.



AB = 1 m.

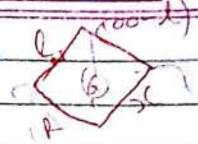


resistance box.

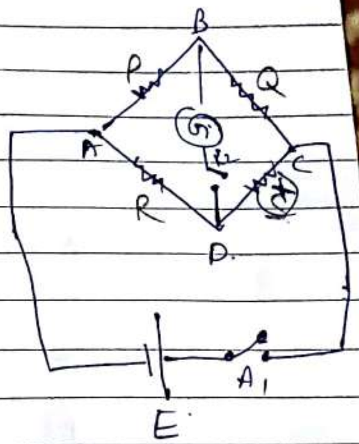


$$\frac{P}{Q} = \frac{R}{S}$$

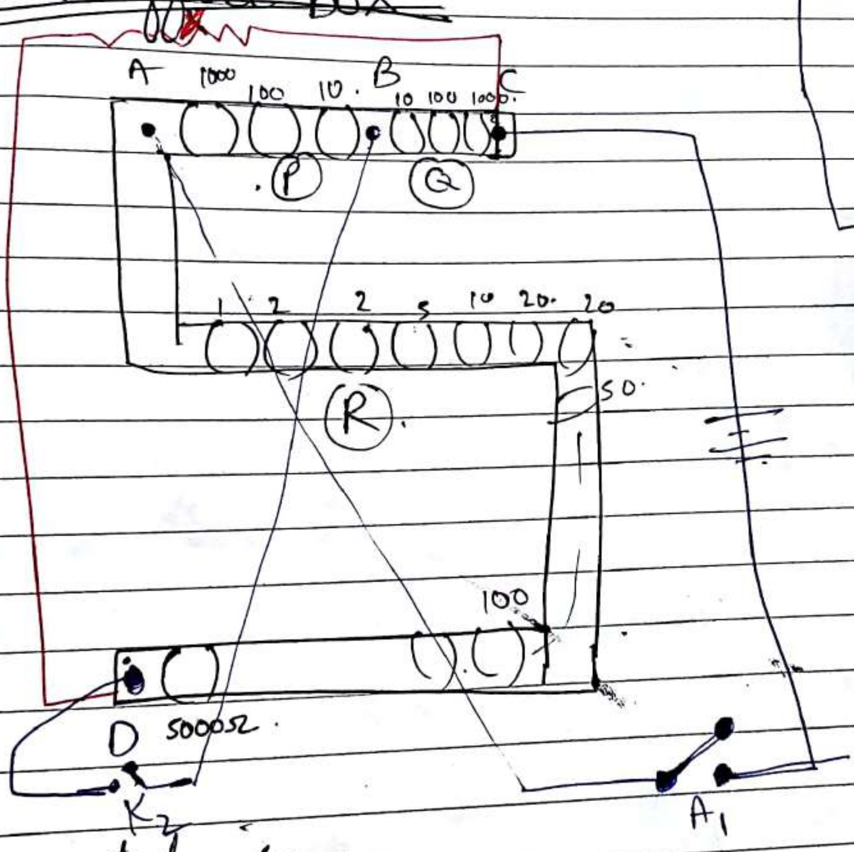
$$\frac{\lambda l}{\lambda(100-l)} = \frac{R}{x}$$



$$\boxed{X = \frac{R(100-l)}{l}}$$



Post office box



Circuit diagram

$$\frac{P}{Q} = \frac{R}{S}$$

$$\boxed{X = \frac{Q}{P} R}$$

by exp i) $P = 10$ $Q = 10$

$$\boxed{X = R}$$

ii) $P = 100$ $Q = 10$

$$\boxed{X = \frac{R}{10}}$$ $\boxed{R = 10x}$