Inverse Trigonometry

Current Electricity

(1) Drift Velocity:-

$$\Rightarrow V_d = \frac{eE\tau}{m_e}$$

- E = Electric field
- e = charge of $\bar{e}$
- τ = Relaxation time
- m_e = mass of $\bar{e}$

(2) Mobility:-

$$\Rightarrow \mu = \frac{e\tau}{m} \quad \text{or} \quad \mu = \frac{V_d}{E}$$

Note:- If drift velocity doubled then mobility remains constant or same Because It does not depend upon E and V_d.

(3) Current:-

$$\Rightarrow \boxed{I = \frac{Q}{t}} \quad \text{or} \quad I = neAV_d$$

- n = no of $\bar{e}$ per unit volume (carrier density)
- A = Area of cross section
- e = charge of $1\bar{e}$

$$\boxed{I = \frac{dq}{dt}} \quad \text{or} \quad I = \vec{J} \cdot \vec{A}$$

- $\vec{J}$ = Current density
- $\vec{A}$ = Area of cross-sect

$$I = JA\cos\theta$$

- θ = Angle between $\vec{J}$ and $\vec{A}$.

$$I_{ave} = \frac{Q_T}{T}$$

(4) Microscopic Scopic or Vector Form of ohm's Law:-

$$\Rightarrow \vec{J} = \left(\frac{ne^2\tau}{m}\right)\vec{E}$$

$$\boxed{V = \frac{mil}{ne^2\tau A}} \quad \text{or} \quad \boxed{R = \frac{ml}{ne^2\tau A}}$$

- l = length of Conductor
- n = carrier density

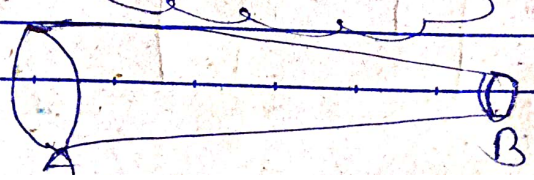
(5) Current Density:-

$$\Rightarrow \vec{J} = \frac{I}{A} \qquad \vec{J} = ne\vec{V_d}$$

Current $\rightarrow I_A = I_B$

Current density $\rightarrow J_A < J_B$

Drift velocity $= V_A < V_B$



$\vec{J} = \sigma \vec{E}$ $\sigma = \frac{ne^2\tau}{m}$

↳ conductivity

specific Resistance

Temp ↑ → **Conductors**
↳ α = +ve $\sigma \downarrow$ $\rho \uparrow$

→ **Insulators**
↳ α = −ve $\sigma \uparrow$ $\rho \downarrow$

→ **Semi Conductor**
↳ α = −ve $\sigma \uparrow$ $\rho \downarrow$

(6) Variation of Resistance:-

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

- → Length of Conductor (l)
- → Area of Cross-Section
- → Conductor Material

$R \propto \frac{1}{T}$ $R \propto \frac{1}{C}$

- Good conductors → R ↓
- Bad conductors → R ↑

$R_{new} = n^2 \times R_{old}$ — valid for wire.

- n = Kitne times wire ko Stretch kiya gaya. ('l' kitni times badhi)

(7) Temperature Dependence of Resistance:-

$$R_{Temp} = R_0 [1 + \alpha \Delta T + \beta \Delta T^2]$$

- α (10^{-2} or 10^{-3}) = Thermal Coefficient of 'R' of Ist order
- β = Thermal " " " of IInd Order (10^{-6})

* When β is very Small,

$$R_T = R_0 [1 + \alpha \Delta T]$$

R_0 → 'R' of refrence temp

$0°, 20°, 25°$

Initial Resistance

(8) Conductance:-

⇒ $$G = \frac{1}{R}$$

$R \uparrow \Rightarrow G \downarrow$

$R \downarrow \Rightarrow G \uparrow$

Unit = Ω^{-1}

(9) Conductivity:-

⇒ $$\sigma = \frac{1}{\rho}$$ or $$\sigma = \frac{ne^2\tau}{m}$$

Unit = $\Omega^{-1} m^{-1}$

(10) Specific Resistance:-

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

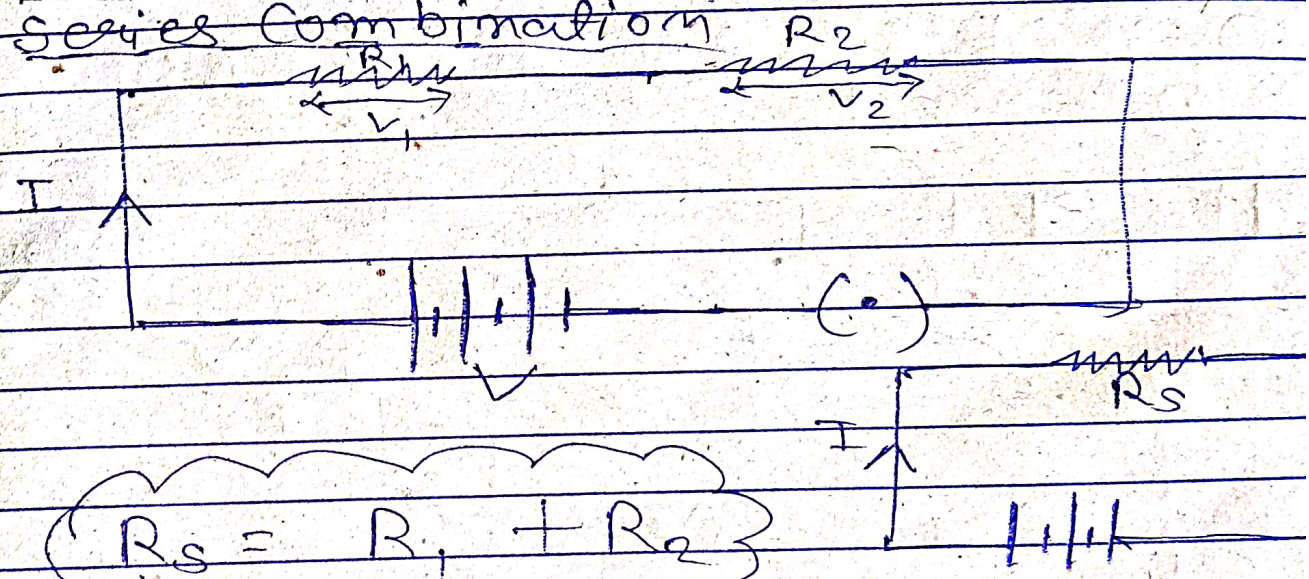
$$\rho = \frac{m}{ne^2\tau}$$

Depend
→ Temp
→ Nature of material

* Unit → $\boxed{\Omega m}$

(11) Combination of Resistance

Series Combination



$$R_s = R_1 + R_2$$

(1) Current = Same in both.
Voltage = May or not be same

$$\boxed{I_{ckt} = \frac{V_T}{R_T} = \frac{V}{R_1 + R_2}}$$

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$V_1 = IR_1 = \left(\frac{V}{R_1 + R_2}\right) \times R_1$

$V_2 = IR_2 = \left(\frac{V}{R_1 + R_2}\right) \times R_2$

$\boxed{R_1 = \frac{R_1 V}{R_1 + R_2} \quad \text{and} \quad R_2 = \frac{R_2 V}{R_1 + R_2}}$

⊙ 'n' Resistors → $R_T = R_1 + R_2 + R_3 + \ldots$

⊙ 'n' equal Resistors → $R_T = \underbrace{R + R + R \ldots}_{n \text{ times}} = nR$

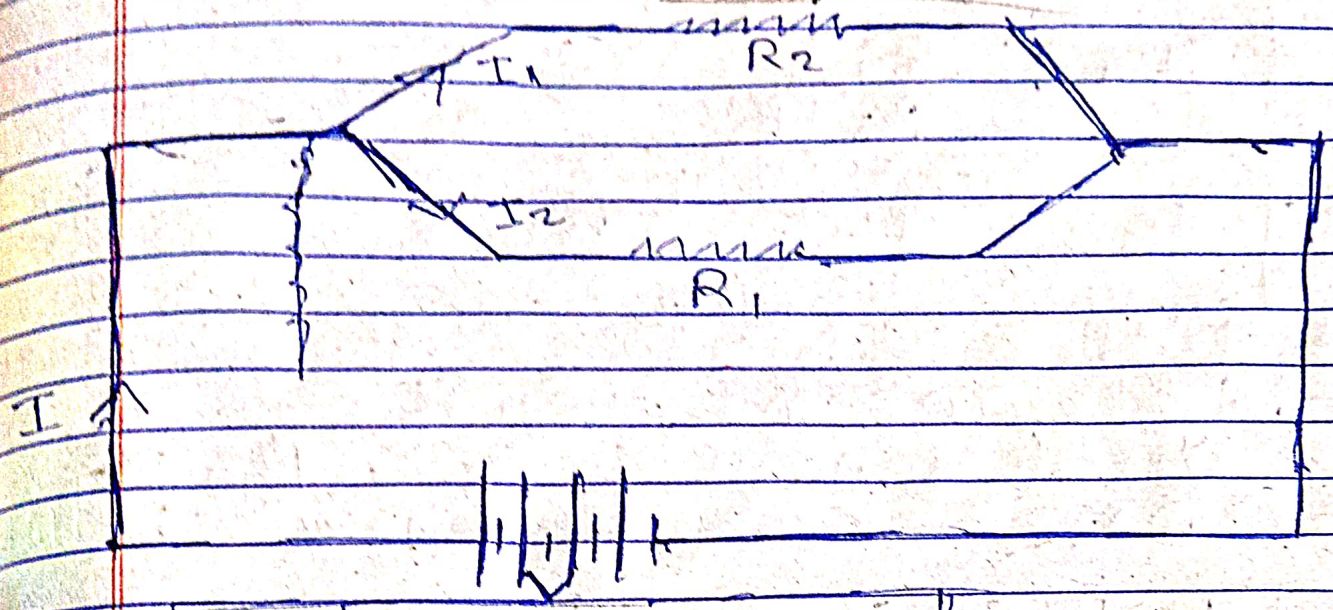
If, $R_1 = R_2 = R_0$ then

$$V_1 = \frac{R_1 V}{R_1 + R_2} = \frac{R_0 V}{2R_0} = \frac{V}{2}$$

$$V_2 = \frac{V}{2} \quad \Big| \quad V_T = \frac{V}{2} + \frac{V}{2} = V$$

It means ⇒ Jab R equal to Voltage bhi equal hoge.

Parallel Combination:-



$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

- V = Constant/same
- I = Current divide.

$$I_T = \frac{V_T}{R_T} = \frac{V(R_1+R_2)}{R_1 \cdot R_2}$$

$$R_T = \frac{R_1 R_2}{R_1+R_2}$$

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

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

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H. If $R_1 = R_2 = R_0$ then

$$I_1 = \frac{R_0 I}{R_0 + R_0} = \frac{I}{2}$$

$$I_2 = \frac{I}{2} \quad \Big| \quad I_T = I$$

→ If means current equally divide hoga Ja 'R' same ho,

(12) POWER FORMULA:-

⇒ $P = VI = I^2R$

$P = \frac{V^2}{R}$ Unit → Watt

Voltage $= \frac{W}{Q}$ (Work done by battery / Charge)

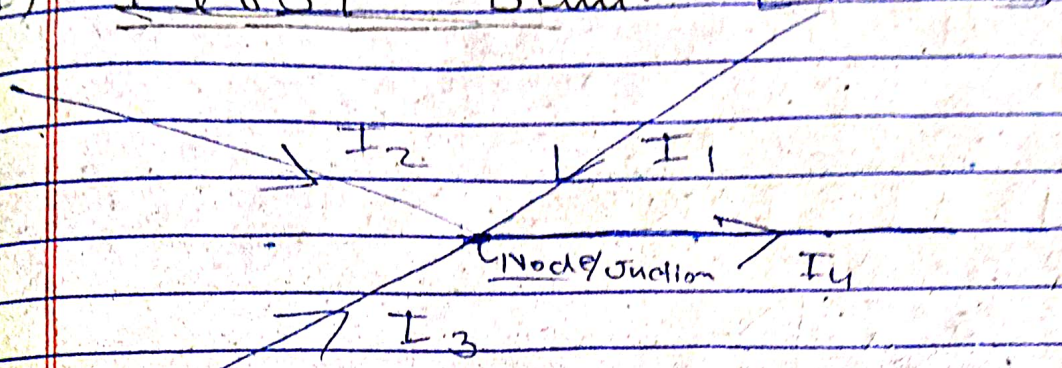
Note:- If 'n' Identical 'R' in Parallel then,

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \text{-----} \; n \text{ times}$$

$$\frac{1}{R_p} = \frac{n}{R} \quad \text{or} \quad R_p = \frac{R}{n}$$

* KRICHHOFF'S LAW :-

(1) First Law :- [KCL]



- Incoming Current = Outgoing Current

$$I_1 + I_2 + I_3 = I_4$$

- Net Current at Any Junction is always zero. $\left(\sum I_{net\ Junction} = 0\right)$

Sign

Incoming Current → −ve
Outgoing Current → +ve

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

(2) Secon Law or loop Law :- [KVL]

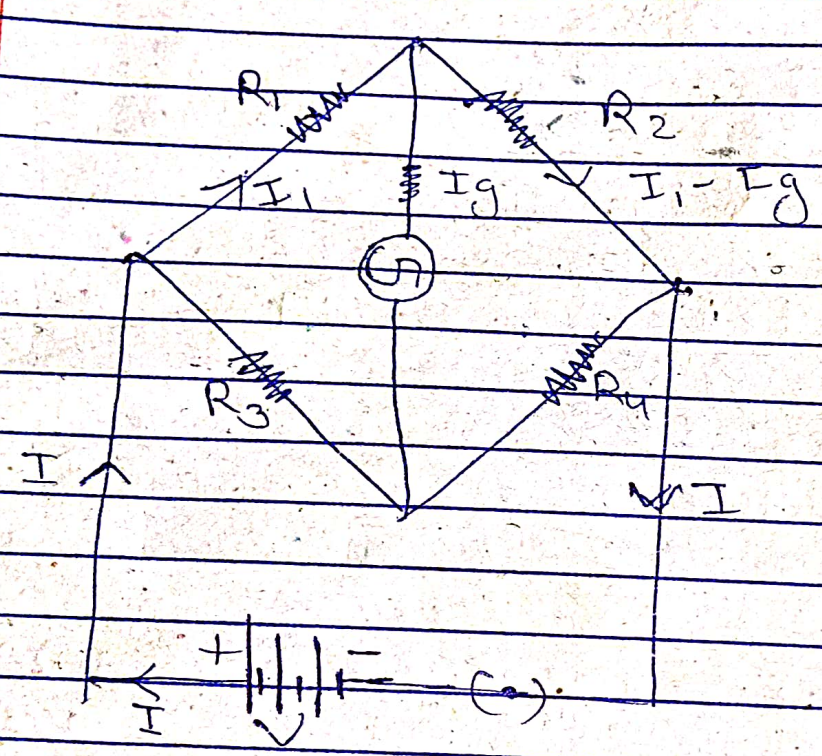
~~KVL~~ Loop

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

Note: The Second Law obey the "law of Conservation of energy".

Note: First law obeys "Conservation of Charge".

* WHEATSTONE Bridge:-



$$I_g = 0$$

Condition for balanced the Wheatstone bridge is

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

→ In this condition

$$V_A = V_B$$

* EMF (Electromotive Force)

$$EMF(\varepsilon) = V + Ir$$ Unit = Volt

- V = Terminal Potential difference
- I = Current in the circuit
- r = Internal resistance of the cell.

Note:- EMF is the Open-circuit Voltage. (When no current flows)

* Terminal Potential Difference:-

$$\Rightarrow V = \varepsilon - Ir$$

- ε = EMF
- I = Current
- r = Internal Resistance

Note:- When no current (I) flows:

$$\boxed{V = \varepsilon}$$

When current flows,

$$\boxed{V < \varepsilon}$$

* METER BRIDGE :-

$$\frac{R_1}{R_2} = \frac{L_1}{L_2}$$

- R_1 = Known resistance (Standard Resistance box).
- R_2 = Unknown Resistance
- L_1 = Length of wire from one end to the null point (Galvanometer).
- $L_2 = (100 - L_1)$ = Remaining length from the other end.

$$R_2 = R_1 \cdot \frac{L_2}{L_1} = R_1 \cdot \frac{100 - L_1}{L_1}$$