Electricity

→ Electric current: rate of flow of charge

$I = \frac{\text{charge}}{\text{time}}$ $I = \frac{Q}{t}$

↳ S.I unit: ampere (A)

Charge: (Q) coulomb (C) — symbol, unit

time: s seconds

→ Charge, it flows because of electrons. Charge is discrete $(x \cdot -1.6\times10^{-19})$

→ smallest possible charge: -1.6×10^{-19} C

if current = 3 A then $\frac{3\,C}{s}$ 3 coulomb / second

$Q = I \times t$

$3A \times 1 = 3C$

$3A \times 2 = 6C$

⇒ Electric Field

→ it is a region around a charged object when another charged object experiences the force (attractive / repulsive).

→ the field direction is from +ve to −ve

→ the arrow in the electric field lines indicates the direction in which the positive charge will experience the force

⇒ Charge Density

Charge density = n = $\frac{\text{No. of charge carriers}}{\text{Volume}}$

drift velocity = v

$n = \frac{N}{V}$

$V = l \times A$

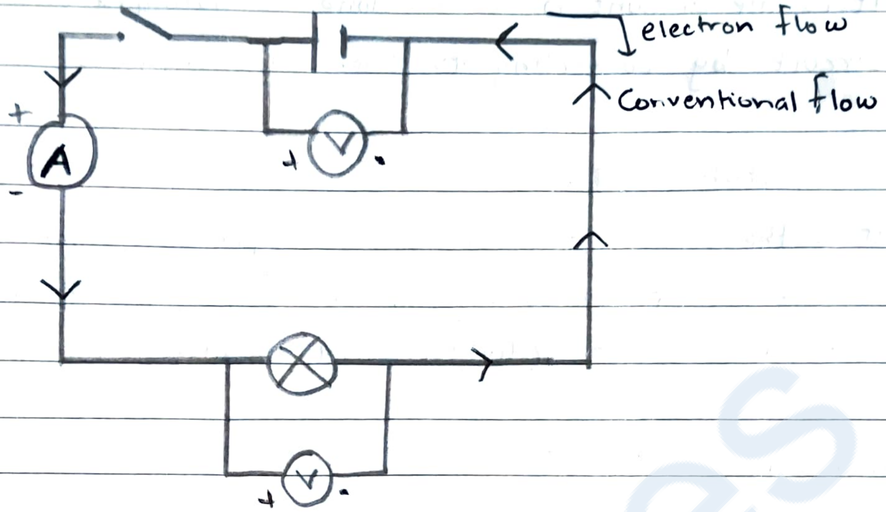
total no. of charges: nV_t

$N = nV$

$Q = n \times l \times A \times q$

$I = \frac{Q}{t} = \frac{nAq \times l}{\frac{l}{v}}$ $I = nAqv$

$I = nAqv$



Voltage = $\frac{\text{workdone}}{\text{charge}}$ $V = \frac{W}{Q}$ S.I unit = $\frac{J}{C}$ or volts (V)

$W = V \times Q$, energy gained by the charge $E = V \times Q$

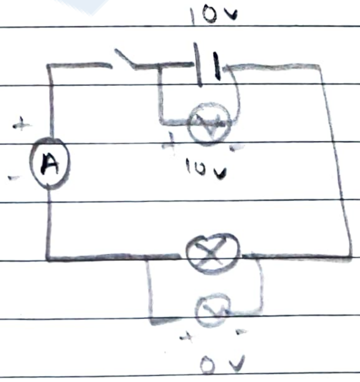
$I = \frac{Q}{t}$ $Q = I \times t$ $E = V \times I \times t$

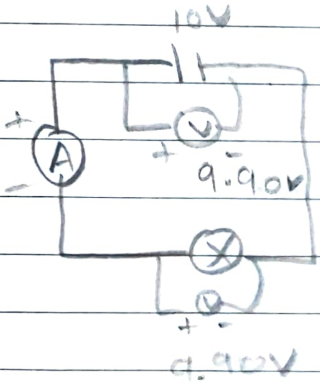
power = $\frac{E}{t} = \frac{V \times I \times t}{t} = \boxed{V \times I}$

↓

S.I unit = watts (W)

⟹ EMF





when circuit is open

$V_1 = 10V$ = emf (electromotive force)

$V_2 = 0V$

When circuit is closed

$V_1 = 9.90V$ (terminal potential diff)

$V_2 = 9.90V$

Lost Volt = 10 - 9.90 = 0.10V

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⇒ EMF

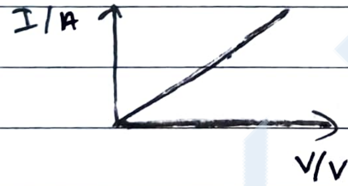
→ it is the amount of work done in moving per unit charge within the circuit by converting its chemical energy to electrical energy.

⇒ Terminal Potential difference

→ it is the amount of work done by per unit charge in moving ~~accross~~ across the appliances by converting its electrical energy into other forms of energy(light, sound, heat)

⇒ ohm's law

→ for a conductor the current is directly proportional to the applied voltage, provided the physical condition of the given conductor remains same. (temp, C.S.A, length)



$V \propto I$

$V = IR$, R = resistance

$R = \frac{V}{I}$

S.I unit = $\frac{\text{Volts}}{\text{Ampere}}$ = VA^{-1} or ohms Ω

Symbol →

resistor

variable resistor

⇒ Resistivity (ρ)

$R \propto l$

$R \propto \frac{1}{A}$

$R \propto \frac{l}{A}$

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

S.I unit for ρ = ~~A~~ Ω m

$R = \rho\left(\frac{l}{A}\right)$ where ρ → resistivity of the given conductor same reshivity

⇒ if two wires of same / material have length l_1 and l_2, cross-sectional Area A_1 and A_2 respectively then →

$$R_1 = \rho \frac{l_1}{A_1} \qquad R_2 = \rho \frac{l_2}{A_2}$$

$$\frac{R_1}{R_2} = \frac{\rho \frac{l_1}{A_1}}{\rho \frac{l_2}{A_2}} \qquad \frac{R_1}{R_2} = \frac{l_1}{A_1} \times \frac{A_2}{l_2}$$

$$\boxed{\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1}} \text{ or } \boxed{\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{d_2^2}{d_1^2}} \text{ or } \boxed{\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{r_2^2}{r_1^2}}$$

Q.

	Wire A	Wire B
length	15 cm	30 cm
diameter	6 mm	3 mm
Resistance	100Ω	x

find x

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{d_2^2}{d_1^2} = \frac{100\,\Omega}{x} = \frac{15}{30} \times \frac{3^2}{6^2}$$

$$\frac{100\,\Omega}{x} = 0.125$$

$$\frac{100}{0.125} = x = \underline{800\,\Omega}$$

Q.

	Wire A	Wire B
l	$2x$	x
r	$3y$	y
	10Ω	z

$$\frac{10}{z} = \frac{2x}{x} \times \frac{y^2}{(3y)^2}$$

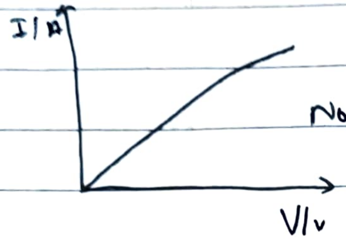
$$\frac{10}{z} = \frac{2\cancel{x}\cancel{y^2}}{9\cancel{x}\cancel{y^2}}$$

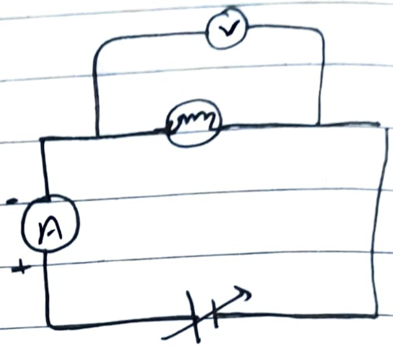
$$\frac{10}{z} = \frac{2}{9}$$

$$\frac{10}{2/9} = z = 45\,\Omega$$

⇒ Filament lamp

I-V graph

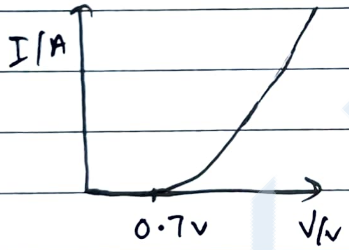


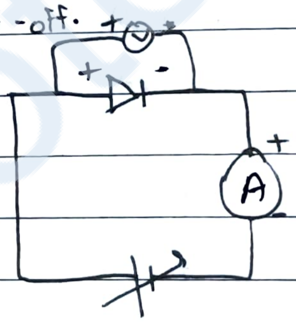


⇒ Diodes

→ semi conductor for device which allows the current to flow in one direction provided it gets the required voltage.

→ silicon diode has 0.7v cut-off.

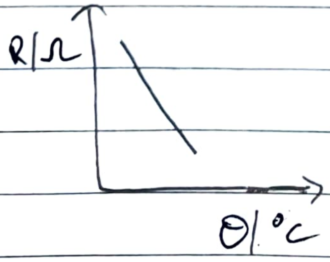


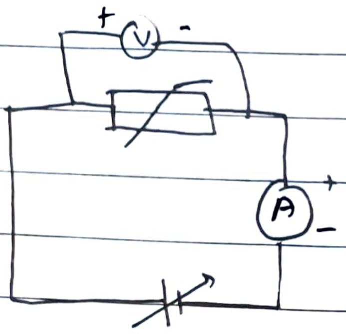


⇒ Thermistor

→ a semiconductor device whose resistance changes with the change in temp around it.

→ at low temp it offers very high resistance, but as temp increas resistances decreases.





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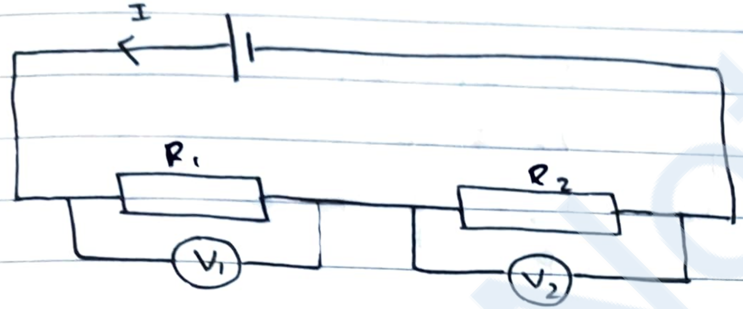
⇒ Resistors connected in series



Total supplied voltage = $V = V_1 + V_2$

current flowing through circuit = $\underline{I}$

$V_1 = IR_1$

$V_2 = IR_2$

$IR_s = IR_1 + IR_2$

$R_s = R_1 + R_2$

R_s = effective resistance in series.

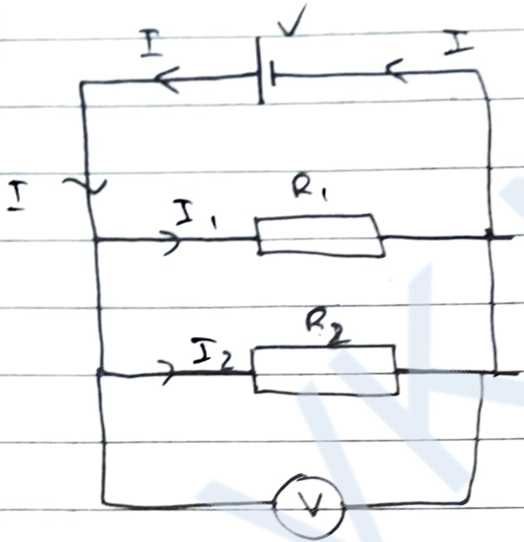
Note:

→ The effective resistance > the individual resistance

→ The voltage in the series circuit gets divided. ↑V↑R

→

⟹ Resistors connected in parallel

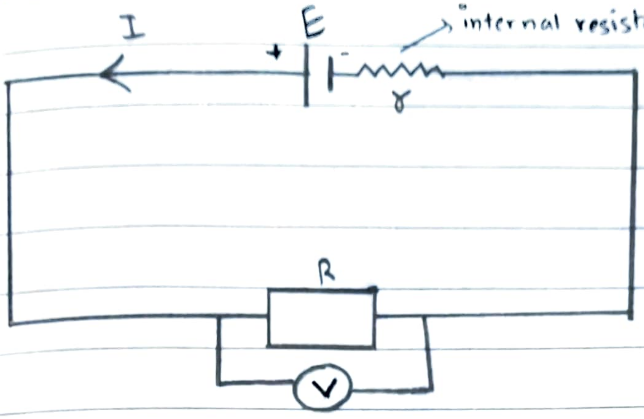


$I = I_1 + I_2$

$V = I R_p$

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

⇒ Internal Resistance



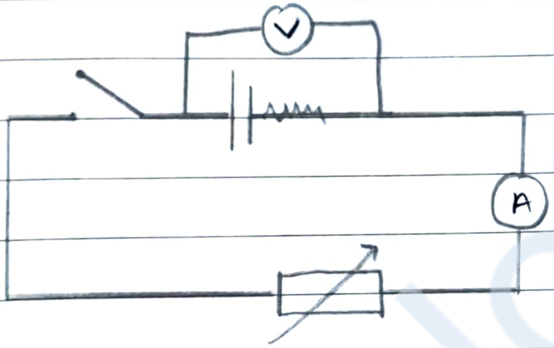
$E = IR + Ir$

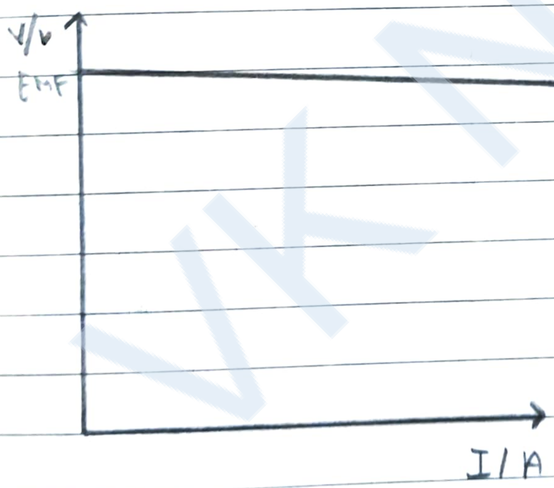
ex. $E = 10V$

but $V = 9.90V$

lost volt = $0.10V$

lost volt is because it internal res





→ Gradient of this graph = internal resistance

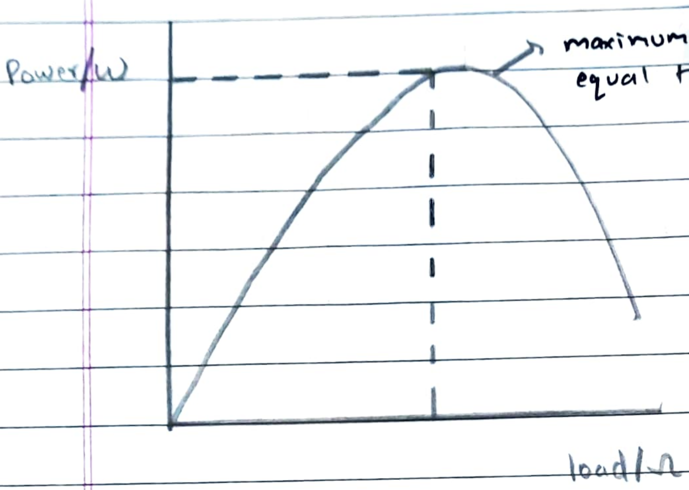
$EMF = V + Ir$

$E = V + Ir$

comparing with $y = mx + c$

$$\underset{\substack{\downarrow \\ y}}{V} = \underset{\substack{\downarrow \\ m}}{-Ir} + \underset{\substack{\downarrow \\ c}}{E}$$

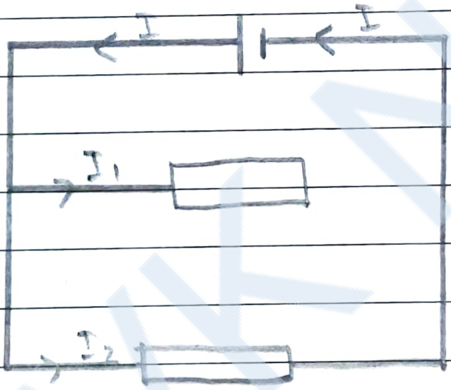
⇒ Power dissipated (graph)



maximum power when load resistance is equal to the internal resistance of battery

⇒ Kirchoff's law

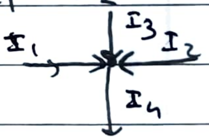
I^{st} law : conservation of charges



sum of current entering the junction is always equal to the sum of current leaving the junction.

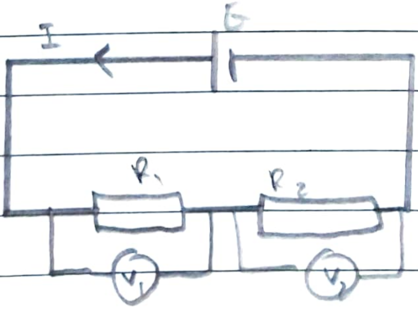
$I = I_1 + I_2$

ex



$I_1 + I_2 + I_3 = I_4$

II^{nd} law : conservation of energy



Sum of the EMF in the circuit is equal to the sum of the potential difference across the components in the circuit.

$E = V_1 + V_2$