ELECTRICITY

CHARGE(Q) :-

(i) Two types of charge ⊕ & ⊖
(ii) SI unit of charge Coulomb (C)
(iii) smallest independent charge electron (e^-)

⊕→ ←⊖ Attract
←⊕ ⊕→ } Repel
←⊖ ⊖→

$1e^- = 1.6 \times 10^{-19}\,C$

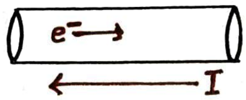
e^- is fundamental charge

CURRENT (I) :-

(i) current is Rate of flow of charge.
(flow of +ve charge)
(ii) Direction of current :- opposite to flow of e^-
(iii) SI Unit of current - Ampere (A)

$I = \frac{Q}{t}$ → C, → s; A (Ampere)

$Q = It$



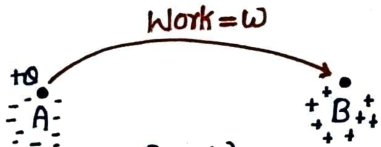
$mA = 10^{-3}A$
$\mu A = 10^{-6}A$

Potential Difference P.D(V) :-

• Potential Difference between two points is amount of work done in moving a unit charge (1C) from one point to the other.

$V = \frac{W}{Q}$ — W → Joules (J), Q → C, V → (V) Volt

$W = QV$ ★ learn

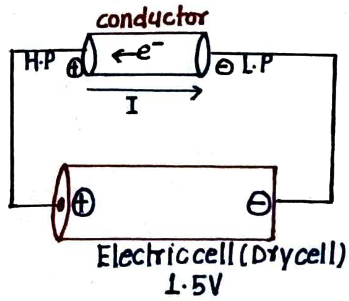


$Q \longrightarrow W$
$1C \longrightarrow \frac{W}{Q}$

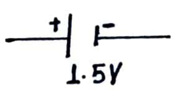
• Potential difference (V) by an instrument Voltmeter.
• Electric current (A) is measured by Ammeter.

Current ka PAPA → Potential Difference (V) [PD] :-

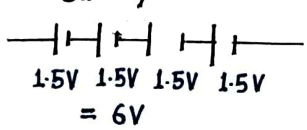
• Electron flows from lower potential to Higher potential.
• I flows from Higher potential to lower potential.



symbol

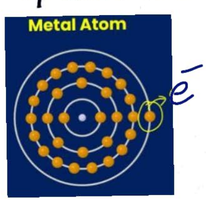


combination of cell
↓
Battery

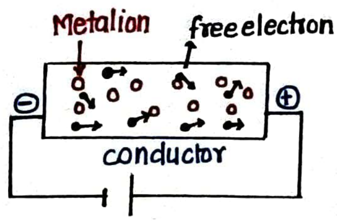


RESISTANCE (R) :-

obstruction offered to the flow of charges. (current)
OR
property of conductor to obstruct flow of charges.



$Q = It$
$W = QV$



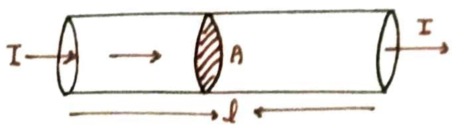
Factors on which Resistance of (Conductor) Depends :-

(i) l :- $R \propto l$

(ii) A :- $R \propto \frac{1}{A}$

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

ohm-Ω ; m ; m^2



(iii) Material $\longrightarrow$ resistivity $\rho \rightarrow$ property of material

l = Length
A = Area of cross section

(iv) Temperature :- Temperature ↑

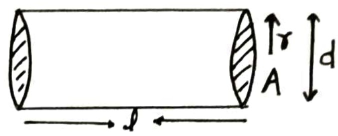
$R = \frac{\rho l}{A}$ • S.I unit of $\rho = \Omega m$

$\rho = \frac{RA}{l} = \frac{\Omega m^{\cancel{2}}}{\cancel{m}}$
$= \Omega m$

• SI unit of R :- ohm Ω

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

in Ω ; in metres ; in m^2 ; in Ωm



diameter = d
$r = \frac{d}{2}$
$r, d \longrightarrow$ mm = 10^{-3}m
cm = 10^{-2}m

$A = \pi r^2$

$R = \frac{\rho l}{\pi r^2}$

$R \propto l \Rightarrow 2l \quad 2R$

$R \propto \frac{1}{A} \Rightarrow 2A \quad \frac{R}{2}$

$R \propto \frac{1}{r^2}$

$2r$ double, $\frac{R}{4}$

same kahani diameter

Resistivity (ρ) :-

unit = Ωm

(1) ρ is a property of the material.

(2) Metals and Alloys have low ρ ($10^{-8}\Omega m$ to $10^{-6}\Omega m$)
Good conductor of electricity.

• Copper and Aluminium are used for transmission lines.

(3) Insulators like Rubber and Glass have high ρ ($10^{12}\Omega m$ to $10^{17}\Omega m$).

OHM'S LAW :-

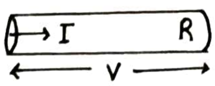
• The Potential difference, V, across the ends of a metallic conductor is directly proportional to the current flowing through it provided its temperature remains the same.

$V \propto I$

$V = IR$

Volt ; Ampere ; Ω ohm

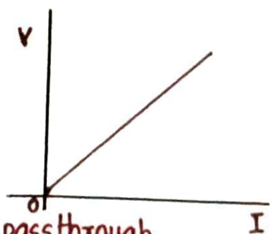
Temp=const.



Trick

VIRal

$V = IR$



pass through origin

OHM'S LAW AND EXPERIMENTAL SETUP :-

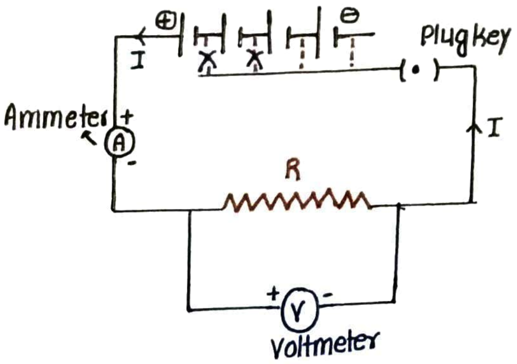
V	I
2V	2I
3V	3I

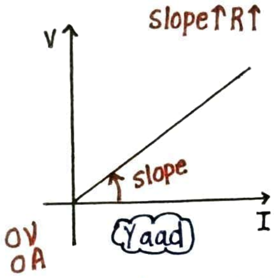
$V \propto I$

$\boxed{V = IR}$

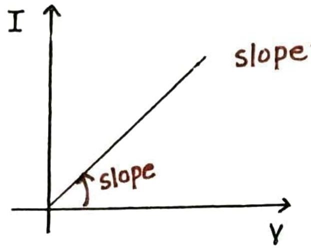
$\frac{V}{I} = R$

$\frac{V}{I} = \text{constant}$

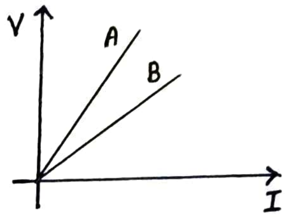




V v/s I st. line pass origin



I-V st. line pass origin



$R_A > R_B$

Combination of Resistors :-

Trick

VIRal

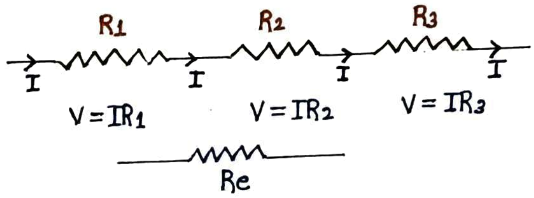
$V = IR$

[1] Series

$I \rightarrow$ same

$V \rightarrow$ Different

$\boxed{R_e = R_1 + R_2 + R_3}$

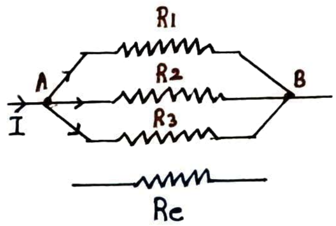


[2] Parallel

$I \rightarrow$ Different

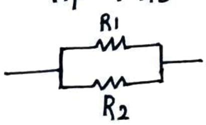
$V \rightarrow$ same

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

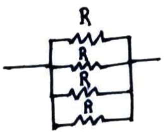


Ye bhi sun le

$R_p < R_s$

✓ 

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

✓ 

$R_p = \frac{R}{n}$

Disadvantage of series combination

(1) if one device fails, all other devices in that series will not work.

e.g. Diwali ki lights

(2) Devices of different types need different current, for eg a bulb and heater needs different current and cannot be connected in series this can be done with parallel combinations.

CIRCUIT DIAGRAM

CIRCUIT- Continuous & closed path of electric current.

Sl.No.	Components	Symbols
1	An electric cell	+ -
2	A battery or a combination of cells	+ 1V 1V 1V =3V
3	Plug key or switch (open)	( )
4	Plug key or switch (closed)	(•)
5	A wire joint	
6	Wires crossing without joining	
7	Electric bulb	or
8	A resistor of resistance R	
9	Variable resistance or rheostat	or
10	Ammeter	+ A -
11	Voltmeter	+ V -

Electric Power :-

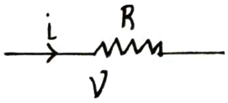
Trick
$P \alpha V \alpha I \Rightarrow P = VI$

• Rate at which electrical Energy is consumed.

① $P = Vi$ — watt, volt, Ampere

② $P = i^2 R$

③ $P = \frac{V^2}{R}$



✡ $V = iR$

✡ $i = \frac{V}{R}$

Electrical Energy (E) :-

supplied by cell

Generally E → unit → Joules (S.I unit)

• $1 kWh = 3.6 \times 10^6 J$

$E = P \times t$

kwh (electrical energy) — in kW ($\frac{watt}{1000}$) — in hr

Bijli ka Bill Banao

Energy ka Paisa

Electric Meter ⇒ 1 unit of energy

1 unit = 1 KWh

Bill = no. of units × price of unit

Energy in KWh
(kitni energy use ki kWh mein)

Heating Effect of Electric current :-

When an electric current passes through a conductor or an electric device, the conductor becomes hot after some time and produce heat. This is called Heating effect of Electric current.

Joule's law of Heating:-

- Heat (H) produced in a Resister.

$H \propto i^2$

$H \propto R$

$H \propto t$

$$H = i^2 R t$$

H → J, i → A, R → Ω, t → s (S.I unit)

R, i, (t)

Pure Resister

$V = iR$

Practical Application of Heating effect of electric current

Alloys → High resistivity ⇒ Heat ↑

Alloys → High Melting point

Alloys → Do not oxide

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

$H = i^2 R t$

$A + O_2 \xrightarrow{Heat} AO_2$

Electric Bulb :-

- filament Tungsten (High melting point) Filament is Heated and it emits light. Most of energy consumed appears as heat, only small part as heat, only small part as light.
- Tungsten has very high melting point

Electric Fuse - Safety Device :-

- Electrical fuse is used to prevent short circuit. fuse has low melting point so when high current passes through it melts and stop the flow of current.

5A melt → Fuse → Appliance → max Current 4.5A

$H = i^2 R t$

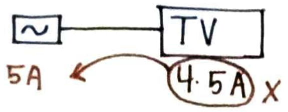
- Fuse wire in series with the appliance.

Fuse wire - Alloy of Al, cu, lead, iron

- Fuse Wire should have $\rightarrow$ High resistivity $\Rightarrow$ Resistance↑ $\Rightarrow$ Heat↑ $\Rightarrow$ Temp↑ $\Rightarrow$ melt
  $\rightarrow$ Low melting point.

- If high current flows (more than required) fuse wire gets heated and melts
  Rating of fuse - 1A, 2A, 3A, 4A, 5A, 10A, etc

- Rating of fuse Wire $\rightarrow$ Max current



Define S.I unit Of Current 1 Ampere. $Q = It$ $\quad I = \frac{Q}{t}$

$I = \frac{Q}{t}$ $\quad 1A = \frac{1C}{1s}$

If one coulomb of charge flows through a conductor in one second, the current flowing through the conductor is known as one ampere

Define S.I unit Of Potential Difference 1 Volt. $W = QV$ $\quad V = \frac{W}{Q}$

$V = \frac{W}{Q}$ $\quad 1V = \frac{1J}{1C}$

The potential difference between two point is said to be 1 volt if 1 Joule of work is done in moving a positive charge of 1 Coulomb from one point to the other.

Define S.I unit Of Resistance 1 Ohm $V = IR$ $\quad R = \frac{V}{I}$

$R = \frac{V}{I}$ $\quad 1\Omega = \frac{1V}{1A}$

One ohm is defined as that resistance of an object when a current of 1 Ampere flows through an object on applying Potential difference of 1V

Define S.I unit Of Power 1 Watt $P = Vi$

$P = Vi$ $\quad 1W = 1V \times 1A$

1 Watt is the Power Consumed in a circuit when 1 Ampere of Current Flows on applying a Potential difference 1Volt.