# ELECTRICITY

- ELECTRIC CURREN AND CIRCUIT.
- a continuous and closed path of an electric current is called an electric circuit.
- why electric current is shown to flow from positive to negative terminal in a circuit diagram?

A. the direction of flow of positive charges was taken to be the direction of electric current. Conventionally, in an electric circuit the direction of electric current is taken as opposite to the directn of the flow of $e^-$.

- How do metals conduct electricity?

A. for any material to be a good conductor of electricity, they must posses free charge carrier.

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- (I) Current = Charge (Q) / time (t). (Q) → SI unit: Coulomb (C), (t) → SI unit: sec → C/sec = ampere (A)
  - Rate of flow of charge.
  - mA = milli ampere → $10^{-3}$ A
  - μA = micro ampere → $10^{-6}$ A.
- charge on electron: $1.6 \times 10^{-19}$ C

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** one ampere is constituted by the flow of one coulomb of charge per second. That is 1A = 1C/1sec.

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- electric current flows in the circuit from the positive to negative terminal of the cell through the bulb and ammeter.

* Properties of Charge:

1. charge is invariant
2. Quantization of charge.
3. additivity of charge
4. Charge is conserved.

## • ELECTRIC POTENTIAL AND POTENTIAL DIFFERENCE.

• we define the electric potential difference between 2 points in an electric circuit carrying some current as the work done to move a unit charge from one point to another.

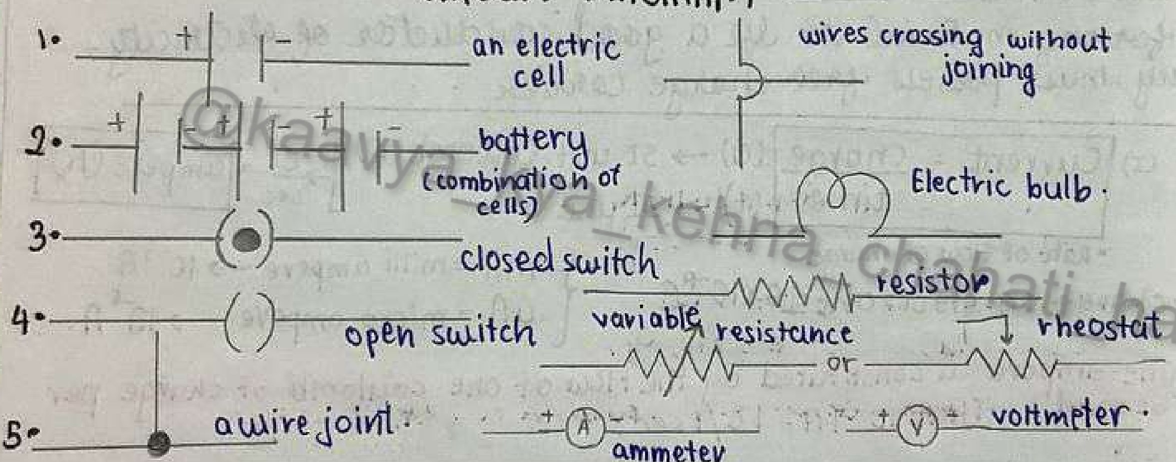
$$\left\{ \text{Potential difference between 2 points } (V) = \frac{\text{work done } (W)}{\text{charge } (Q)} \right\}$$

$1V = 1JC^{-1}$ ⇒ $\boxed{V = \frac{W}{Q}}$

** one volt is the potential difference between 2 points in a current carrying conductor when 1 J of work is done to move a charge of 1 C from one pt to another.

• The p.d. is measured by means of an instrument called VOLTMETER.

### — CIRCUIT DIAGRAM —




## OHM's LAW

• The potential difference (V), across the end of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temprature remains the same.

- $V \propto I$
- $\frac{V}{I}$ = constant
- constant = R
- $\therefore \boxed{V = IR}$ ⇒ more the P.d. more the current
  ⇒ more the resistance more the current.

{ • 1 ohm = $\frac{1 \text{ volt}}{1 \text{ ampere}}$ }

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

*• current through a resistor is inversely proportional to its resistance.

*• a component used to regulate current without changing the voltage source is called variable resistance or rheostat.

## IMPORTANT :

- ammeter reading :

i] decreases by one-half when the length of wire is doubled.
ii] increases when a thicker wire of the same material and of the same length is used.
iii] changes when a wire of diff material, same length and same area is used.

## Resistance of conductor depends upon :-

i] the length of conductor ↘ Resistance
ii] the area of cross-section ↗ Resistance
iii] nature of material ↗ Resistivity
iv] temprature ↗ Resistance

⇒ as we know

$R \propto l$ – ①

and $R \propto \frac{1}{A}$ – ② {SI unit – $\Omega m$}

by ① and ②

$\Rightarrow R \propto \frac{l}{A} \Rightarrow \boxed{R = \rho \frac{l}{A}}$

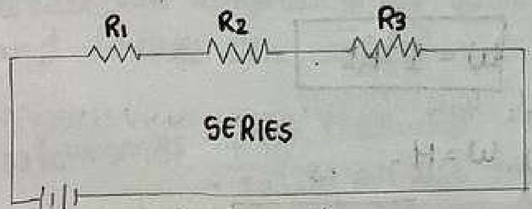
- where $\rho$ (Rho) is a constant of proportionality and is called the electrical Resistivity.

- metals and alloys have low resistivity.
  → good conductors of electricity.
- Insulators have a high resistivity.
  → bad conductors of electricity.



## • COMBINATION OF RESISTORS •

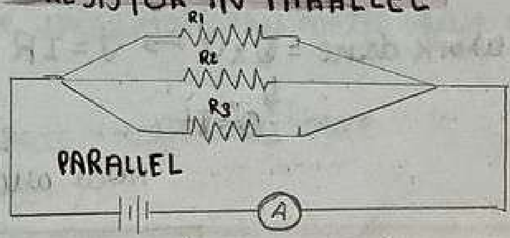
- RESISTOR IN SERIES




- total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors.

$$[R_s = R_1 + R_2 + R_3]$$

- RESISTOR IN PARALLEL




- reciprocal of the equivalent resistance of a group of resistances joined in a parallel is equal to the sum of reciprocal of the individual resistance.

$$\left[\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

• points to be noted

⇒ series circuit the current is constant throughout the electric current.

∴ disadvantages of series circuit :

① if one component fails the circuit is broken and none of the components works.

Eg :- fairy lights : if one bulb breaks the wire after that broken bulb gets dead.

∴ advantages of parallel circuit :

The total resistance in a parallel circuit is decreased. This is helpful particularly when each gadget has different resistance & requires different current to operate properly.

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## HEATING EFFECT OF ELECTRIC CURRENT:

★ Joule's Law of Heating :-

• it states that, "heat generated in a current in a conductor is directly proportional to the square of current, resistance of conductor and time period of current flow.

Q. How does electron flow in a conductor of a circuit?

→ The chemical reactⁿ within the cell generates the potential diff between its 2 terminals that set the $e^-$ in motion to flow the current through a resistor or a system of resistors connected to battery.

• Work done $= Q \times V \rightarrow V = IR$

$\downarrow$ $Q = It$

$\therefore \boxed{W = I^2Rt}$

now assuming $W = H$.

$\boxed{W = H = I^2Rt}$ also $\boxed{H = VIt}$

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ELECTRIC POWER: The rate at which the work is done by battery in maintaining the current in electric circuit is called electric Power of circuit.

$\because$ $\boxed{\text{Power} = \frac{W}{t}}$ as $W = I^2Rt$

* $\Rightarrow$ $\boxed{P = I^2R}$ → current → Resistance.

now as $V = IR$ ⤻ $I = \frac{V}{R}$

* $\Rightarrow$ $\boxed{P = \frac{V^2}{R}}$ → voltage → Resistance.

$\Rightarrow P = I^2 \times \frac{V}{I}$ * $\Rightarrow$ $\boxed{P = VI}$

* Commercial unit

- $1 \text{ kWh} = 1000 \text{ watt} \times 3600 \text{ sec}$
- $1 \text{ Kilowatt} = 1000 \text{ watt}$

$\Rightarrow$ one watt hour is the energy consumed when 1 watt of power is used for 1 hour.

## APPLICATIONS OF HEATING EFFECT OF ELECTRIC CURRENT.

Q. why tungsten filament is preffered over any other metal for electric bulb?

→ The electric heating is also used to produce light, as in an electric bulb. Here the filament must retain as much of the heat generated as is possible, so that it gets very hot and emits light. It must not melt at high temp $\therefore$ Tungsent of high melting is used.

- The bulb are usually filled with chemically inactive nitrogen and argon gases to prolong the life of filament.
- most of the power consumed by filament appears as heat.

If a current larger than the specified value flows through the circuit the temprature of fuse wire increases. This melts fuse wire and breaks the circuit.

* Nichrome: • high Resistivity • High heat • High resistance
• easily oxidise nhi hota.

all formulae:

① $I = \frac{Q}{t}$ (ampere = coulomb / sec) ② $Q = ne$ ($e = 1.6 \times 10^{-19}$) ③ $V = \frac{W}{Q}$ (volt = Joules / coulomb) ④ $V = IR$ (volt = ampere · Ω) • $R = \frac{V}{I}$ (Ω = volt / ampere) • $I = \frac{V}{R}$ (ampere = volt / Ω) ⑤ $R = \rho \frac{l}{A}$ (Ω = Ω m · m / $m^2$)

⑥ • $H = VIt$ (Joules = volt · ampere · sec) • $H = I^2Rt$ (Joules = $\text{ampere}^2$ · Ω · sec) ⑦ • $P = VI$ (watt = volt · ampere) • $P = I^2R$ (watt = $\text{ampere}^2$ · Ω) • $P = \frac{V^2}{R}$ (watt = $(\text{volt})^2$ / Ω)

- $\text{ohm} = \frac{\text{volt}}{\text{ampere}}$ • $\text{ampere} = \frac{\text{coulomb}}{\text{sec}}$ • $\text{volt} = \frac{\text{Joule}}{\text{coulomb}}$.

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