Date: / / Page no:

chapter - 3

# Electricity

Notes :

* Electric circuit :- A continuous and closed path of an electric current is called an electric circuit.

* Electric charge :- charge is the property associated with matter due to which it produces and experience electrical and magnetic effects

SI unit of charge : coulomb (C)

$1 mC = 10^{-3}$

$1 \mu C = 10^{-6}$

* Where does the charge present in the universe?

A → Charge is fundamently present on the elementry particles, electrons (-) and protons (+) and Neutrons are Neutral in nature. All of them are present inside the Atom constitute to become molecules, of which the substance of the universe are made

Properties of charges :

1) Additivity of charge : Total charge on a body is the algebraic sum of all the charges located anywhere on the body.

Note :- Charge is a scalar quantity.

2) Charged is conserved: charge can neither be created nor be destroyed that means for an isolated System total charge is conserved/constant.

3) Charge is Invariant : The numerical value of an

Date: / / Page no:

elementary charge is independent of velocity.

④ Quantization of charge:

- The smallest charge that can exist in nature is the charge of an electron.
- If the charge of an electron [$= 1.6 \times 10^{-19}$ C] is taken as elementary unit i.e. the quanta of charge, the charge on any body will be some integral multiples of e.i.c ~~no~~ $Q = \pm ne$ with $n = 1, 2, 3, 4 \ldots$

$$Q = ne$$

where, $Q$ = Net charge on Body
$N$ = No of electron
$e$ = Electric charge on $1e^-$

Electrical Substance. ($\downarrow \downarrow \rho$)

1) conductors: The substance or material that permit electrons to flow freely from practice to particle. eg - copper, Iron, silver.

* This is due to presence of more loosely bound electrons [free electrons]. See Electron Model.

2. Semi conductors: (medium Resistivity)

- A Material that has an electrical conductivity value falling between that of a conductor such as metallic copper and an insulator, such as glass eg - SiAs, GaAs, Titanium Dioxide etc

* This is due to the presence of less free electrons which are tend to move to conduct electricity.

$\uparrow\uparrow \rho$

3. Insulators:- The substance or materials that resist the free flow of electrons from atom to atom

and molecule to molecule. eg - wood, ~~ett~~ Glass etc.

* This is due to the absence of more loosely bound electrons [free electrons].

Electric current :- flow of charge per unit time or
The amount of electric charge flows through any cross section in unit time.

$$\text{Current} = \frac{\text{Amount of charge}}{\text{time}}$$

$$I = \frac{Q}{t} \begin{array}{l} \rightarrow \text{Coulomb (C)} \\ \rightarrow \text{second (s)} \end{array}$$

$I \rightarrow$ Ampere (A)

$1\,mA = 10^{-3}A$

$1\,\mu A = 10^{-6}A$

SI unit of current is Ampere or ~~cot~~ coulomb/second
A or (C/s)

Define 1 Ampere :- when 1 C of charge flow in 1 second then current is said to be 1 A.

Electric potential :- The amount of work done in bringing unit positive charge from infinity to point in electric field is electric potential.

$$E.P = \frac{\text{work done}}{\text{charge}} = J/C \text{ or volt unit}$$

E.P is ~~denote~~ also called Voltage (V).

define 1 volt :- if 1 Joule of work is said to be done in bringing unit positive charge from infinity to any point in electric field.

$$V = \frac{W}{q} = \frac{1}{1} = 1V$$

Electric potential is donated by V.
SI unit of E.P is J/C or volt.

Date: / / Page no:

Potential Difference ~~is~~ The amount of workdone is move in unit positive charge from one point to other point inside electric field.

S.I unit is V, Denoted by V.

→ Voltage is directly proportional to current $\boxed{V \propto I}$

* Current is inversely proportional to resistance $I \propto \frac{1}{R}$

Ohm's law

$V \propto I$ where V = Voltage

$V = RI$ I = current

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

$T\uparrow = R\uparrow$

Temp.

Statement :- According to ohm's law :- At constant temprature, the current flowing through a conductor is directly ~~to~~ proportional to the potential difference across its ends. / points

Resistance of a conductor

The property of a conductor due to which it oppose the flow of current through it is called resistance.

S.I unit of resistance is ohm.

* The resistance of a conductor is depends on length, thickness, nature of material and temprature of the conductor.

Factors Affecting Resistance.

1. Length of the conductor (l) m.

$R \propto l$

2. Cross sectional Area of conductor (A) $m^2$

Date: / / Page no:

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

3 Material of wire ($\rho$) → Rho Ωm
4 → Temperature (T)

$R \propto l$ , $R \propto \frac{1}{A}$ = $R \propto \frac{l}{A}$ = $R = \rho \frac{l}{A}$

R = resistance ; $\rho$ → Resistivity of material
unit of resistivity is Ωm
$R = \rho$

Difference B/w Resistance (R) and Resistivity ($\rho$)

| Resistance (R) | Resistivity ($\rho$) |
|---|---|
| → opposition offered by the atomic particles in the path of current | It is the property which is material dependent to offer opposition to current. |
| → denoted by R | $\rho$ → Rho . Denoted |
| → It depends on length area and material of the wire also temp. | - It depends on temp. and nature of the material |

Series circuit :- In series combination of resistance the resulted resistance is equal to same of all individual resistance

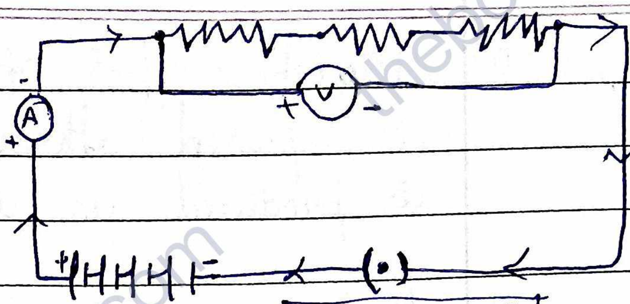
Properties
1. Current remains same through all resistors.
2. Voltage divides itself on all resistors in proportion to the value of resistance
$V \propto R$

$V = V_1 + V_2 + V_3$

$IR = IR_1 + IR_2 + IR_3$

$\cancel{I}R = \cancel{I}[R_1 + R_2 + R_3]$

$IR = R_1 + R_2 R_3$



~~$I \uparrow \propto R \uparrow$~~ $\boxed{I \uparrow \propto R \uparrow}$

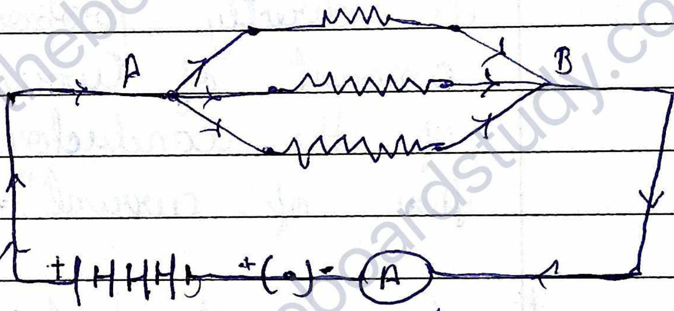
Parallel combination

Resipical of resulted resistance is equal to sum of resiporal of all individual resistance.

Properties :-

1. I divides itself according to resistances in inverse ratio.
2. V remains same.

$R \uparrow \quad I \downarrow$



$TI = I_1 + I_2 + I_3$

$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

$\boxed{I \downarrow \propto \frac{1}{R \uparrow}}$

$\frac{\cancel{V}}{R} = \cancel{V}\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$.

Three Effects of current

1) chemical effects of current : when Electric current is passed through the conducting solution it causes chemical reactions to occur on cathode and anode. example electroplating, Hydrolysis, formation of sodium Hydroxide [NaOH]

$R = 6$

$I = 2A$

$V = 2 \times 3$

$V = 6$

2. Magnetic effect of current : when electric current is passed through a conductor, magnetic field is produced in the area around the conductor.

3 Heating Effects of current: when current is passed through a conductor, due to repetitive collisions between moving charges and atoms, heat energy and power is dissipated.

## Joule's Law of Heating

It states that "Heat produced in a conductor is directly proportional to the square the amount of Current flowing (I), Resistance (R) of the conductor, Time period (T) of the flow of current".

* Proof of Joule's law:

$$V = \frac{W}{Q}$$

$V Q = W$

$I t I R = W \quad [Q = It, \; V = IR]$

$W = I^2 R T$

$$\boxed{H = I^2 R T}$$

$V = \frac{W}{Q}$

$V = IR$

$W = VQ$

$Q = It$

$W = IR\, It$

$W = I^2 R t$

## Practical Application of heating Effects

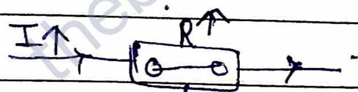
· Electric Bulb

Bulb is filled with nitrogen or Argon gas

Date: / / Page no:

The filament of bulb is made up of tungsten (W)
It is pure metal. Very high Melting point 3380°C

2 Electric fuse :




↳ fuse wire made up of Cu, Ni Alloy
Sn + Pb Alloy.

M.P very low → current exceed → wire meltdown → circuit Breaks.

3 Heating element :-
Geyser, electric kettle, Electric heter, Iron rod etc.
Made up of Nichrome Alloy.
$\rho\uparrow$, $R\uparrow$, $H\uparrow$

$P = \frac{W}{t}$ $P = \frac{QV}{t} = IV (W)$
Electric power = $I V \times t$

Electrical power

$P = \frac{W \text{ (Joule)}}{t \text{ (sec)}}$ (watt)

Electric Power = $\frac{\text{Electric Energy}}{\text{time}}$ ⇒ $\boxed{PT = \mathcal{E}}$

General = $\mathcal{E} = VIT$
series = $\mathcal{E} = I^2RT$
parrale = $\mathcal{E} = \frac{V^2}{R}T$

Derivition
$P = \frac{W}{t} \rightarrow \frac{QV}{t} \rightarrow \boxed{IV}$ → General
$V = \frac{W}{Q} \Rightarrow W = QV$
series = $IV$
$= IIR$
series = $I^2R$

$(V = IR)$
parallel = $IV$
$= \frac{V}{R} \times V = \frac{V^2}{R}$

Commercial unit of energy.
S.I unit → Joule (J)
Pratical unit (Heat) → Calorie
commercial unit = Kilowatt hour (Kwh)
$\mathcal{E} = P \times T$ $1 \text{ Kwh} = 3.6 \times 10^6 \text{ J}$.

Date: / / Page no:

* Static current :- Is a type when electronic charges dep develop but do not flow.
Ex: charges developed by glass road and silk