Electric Current

Columb(C) charge: fundamental particle of matter $\{Q = ne\}$ charge
↳ +tive, −tive (++, −− repel note of e^-
+−, −+ attract)

Static Electricity: deals with electric charges at rest while the current electricity deals with charges in motion

Ampere(A) Electric Current Rate of flow of electric charge
(I) $\{I = Q/t\}$ (scalar)
∴ charge on 1 e^- is $= 1.6 \times 10^{-19}$ C
(1 Ampere is said when 1 Columb of charge flows through any cross section in 1 second.

Volts (V) Potential Difference: work needed to move a charge from one point to another a.k.a Voltage
$\{(V) = \frac{W}{Q}\}$ (work done) (charge)

∴ flow of electric current is opposite to flow of electrons
electrons flow −tive to +tive
electric current flow from +tive to −tive

Electric circuit: a closed path along with electric current flows.

Symbols

+|I− battery cell

resistor

variable resistor

+|I|I− battery

electric bulb

+(A)− ammeter

—( )— switch off

+(V)− voltmeter

—(•)— switch on

Electric Current

Ohm's Law: the current through a conductor is directly proportional to the voltage across the two points provided external conditions are constant

$(I \propto V)$

$\boxed{V = IR}$ (resistance)

ohm (Ω) * Resistance: interruptions in current flow.
(R) (property of conductor to resist flow of current)

⇒ factors on which resistance depends.

$R \propto \frac{1}{A}$ (area) $R \propto l$ (length)

$R \propto$ material $R \propto$ temperature

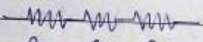
(resistivity) (ρ) Ωm

resistance offered by a material wire of 1m length and $1m^2$ area (cross section).

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

Series Resistance Connection

connection in one line (horizontal)



R_1 R_2 R_3

Final R is more than individuals.

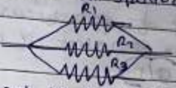
$$\boxed{R_S = R_1 + R_2 + R_3}$$

- I is constant
- V is different

$$\boxed{V_S = V_1 + V_2 + V_3}$$

Parallel Resistance connection

connection in splitted parallel connection



$R_p = \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

· current in splitted case

$I_p = I_1 + I_2 + I_3$

· voltage is same

· final R is less than any individual R.

Heating Effect of current:

$H \propto I^2$

$H \propto R$ so $H = I^2Rt = H = IVt = H = \frac{V^2}{R}t$

$H \propto t$

watt power $= \frac{Q}{T} = \frac{V^2}{R}\frac{t}{t} = \frac{V^2}{R} = IV = I^2R$

↳ rate at which electricity is consumed

Commercial unit: $1kWh = 3.6 \times 10^6$ $(1000 \times 60 \times 60)$

a.k.a units

Conductance: Ability of a material to allow flow of electric current.

Power:

power = $\frac{\text{workdone}}{\text{time}} = \frac{W}{t}$ $(V = W/q)$ $= \frac{Vq}{t}$

so $P = \frac{Vq}{t}$, $P = VI$

$H = Pt = VIt = I^2Rt$

v1 · e From ~~PDF~~ JA e ....

Ampere A — Electric Current: rate of flow of current
(I) opposite to the direction of electron flow
Scalar $\boxed{I = Q/T}$

Ohm's Law

the potential difference between two points is directly proportional to electric current passing through them at constant temperature

$$V \propto I$$

volts (v) voltage ← $\boxed{V = IR}$ → resistance ohm (Ω)
Electric Current
Ampere (A)

$R \propto l$ (length) m $\quad \boxed{R = \rho \frac{l}{A}}$

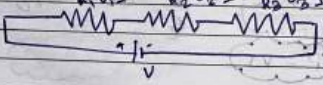
$R \propto \frac{1}{A}$ (area) m^{-2}

$R \propto T$ (temperature) k

$R \propto \rho$ (resistivity) Ωm $[\rho = \frac{1}{\sigma}]$

V2 Resistor connections

* 3 Resisters in Series



here, I is same for all by V is different

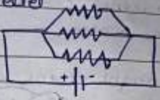
so $V = V_1 + V_2 + V_3$ $\quad (\because V = IR)$

$$IR_{eq} = IR_1 + IR_2 + IR_3$$

$$\boxed{R_{eq} = R_1 + R_2 + R_3}$$

$\therefore R_{eq}$ is always >> than every R_n...

In parallel

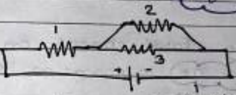


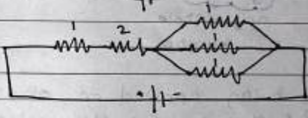
here V is same of Rs.
But I splits so...
Req is smaller than every R_n

$$I = I_1 + I_2 + I_3 \quad (I = V/R)$$

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \Rightarrow \boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

V_3 Solve this





$\boxed{\frac{1}{\Omega m}}$ or Conductivity: property of a material to allow flow of current through it.
siemens/meter
$\boxed{S/m}$ (σ) is the constant property of the material
because $\frac{1}{\Omega} = S$ $\quad \sigma = \frac{1}{\rho}$

so geometrically $\sigma = \frac{L}{RA}$ (only for geometry)

Heating Effect of Current

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

+tive p^+
-tive e^- Electric Charge — oppo attract (+, −)
same repel (−−, ++)

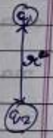
property of a electron, proton or neutron.

∵ when 2 electrons brought at the distance of 1 cm, force experience is 2.3×10^{-24} N
same force for protons too
charge on 1 $e^- = -1.6 \times 10^{-19}$ C
1 $p^+ = 1.6 \times 10^{-19}$ C

calculating total charge on a body
charge ← $Q = ne$ → charge on 1 e^- (1.6×10^{-19})
n → any whole number

Force being applied on charges :
↳ $F \propto q_1 q_2$ (multiplication of charges)
$F \propto \frac{1}{r^2}$ → r → radius between them

$F \propto \frac{q_1 q_2}{r^2}$



$$F = K \frac{q_1 q_2}{r^2}$$

K → ~~coloumb~~ coulomb's constant = 9×10^9

$$K = \frac{1}{4\pi \varepsilon_0}$$ → ε_0 → permittivity of space

permittivity is the measure of how much resistance is encountered when forming an electric field in a medium.

$\boxed{K \text{ unit} = \frac{Nm^2}{C^2}}$, $\boxed{\varepsilon_0 \text{ unit} = \frac{C^2}{Nm^2}}$

vector
E (N/C) Electric Field — property of a electric charge carrying body

$$\boxed{E = \frac{\text{Electric Force}}{\text{test charge}}}$$

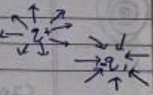
unit = $\boxed{\frac{N}{C}}$

$$E = \frac{k\frac{q_1 q_0}{r^2}}{q_0} = \boxed{\frac{kq}{r^2} = E}$$

it is a vector quantity in direction of the electric force

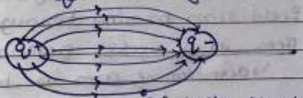
$$\boxed{\vec{E} = \frac{kq}{r^2}} \quad \boxed{\vec{E} = \frac{\vec{F}}{q_0}}$$

if q^+, E is radially away from center
q^-, E is radially towards the center



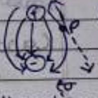
E only gets 0 when $r = \infty$ ($\because E = kq/r^2$, $r \to \infty$)
E get ∞ when $r = 0$ ($E = kq/r^2$, $r \to 0$)
so, E↑ increase as we go closer

Properties Stated By michel Faraday...
1) electric field start from +charge and ends at negative charge



P (what's direction of E?)

"they said draw a tangent, and it shows direction of E for that point," but direction toh kai bhi direction ki bana du... ?! like this..



2) E don't make closed paths, like bidirections
3) E field lines don't interpect

Electric Potential / Electric Potential Difference

Electric Potential: work done per unit charge in bringing a positive test charge from ∞ to that point, against electric force.

$\cancel{V = \frac{W_{ext}}{q_0}}$

[Scalar] Electric Potential Difference: Different between electric potentials of two points,

$V_A - V_B = \frac{W_{ext}}{q_0}$ in opposite to the direction of electric field

unit = $\boxed{J/C \text{ or volts}}$

(Integration vala kuch hai but it's too confusing)

$V = E.r$ $V = \frac{kq}{r}$

$\boxed{\frac{N m^2}{C}}$ $\boxed{Vm}$ **Electric Flux**: measure of total number of electric field lines passing through a given surface

$\because$ Area is a vector quantity in physics.
↳ direction of area is $\perp$ to the surface

$\Phi = \vec{E}.\vec{A} = E.A.\cos\theta$

Scalar

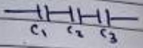
Capacitors

ability of a conductor (or capacitor) to store electric charge per unit potential difference

so $C = \frac{Q}{V}$ $VC = Q$ unit: $\boxed{\text{Farad (F)}}$

* Connections of capacitors

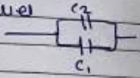
1. Series



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

(∵ voltage differs)
(∵ charge remains same)

2. Parallel



$C_{eq} = C_1 + C_2$

∵ voltage remains same
∵ charge changes