③ * Current electricity *

① Electric current

$I = \frac{\text{Charge}(q)}{\text{Time}(t)}$ ↳ as $q = ne$

$I = \frac{ne}{t}$

1 ampere = $\frac{1\ \text{coulomb}}{1\ \text{second}}$

→ Current in domestic appliance = 1 A
→ Current carried by lightning = 10^4 A
→ Current in our nerves = 10^{-6} A = 1 μA

② Period of revolⁿ of e^-

$T = \frac{2\pi r}{v}$

③ Frequency of revolution

$\nu = \frac{1}{T} = \frac{v}{2\pi r}$

Current (I) = Charge flowing in 1 revolⁿ × No. of revolⁿ per second.

$I = e\nu = \frac{ev}{2\pi r}$

Electric charge → coulomb
Current → Ampere

④ Electromotive force (emf)

emf = $\frac{\text{Work done}}{\text{charge}}$

⑤ Ohm's law

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

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

Factor affecting the resistance
① Length ($R \propto l$)
② Area of cross sectⁿ ($R \propto \frac{1}{A}$)
③ Nature of material ($R = \rho \frac{l}{A}$)
∴ $R = \rho$
S.I. unit of ρ = ohm meter (Ωm)

⑥ Resistivity or specific resistance

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

⑦ Conductance

$C = \frac{1}{R}$ → $ML^{-2}T^{3}A^{2}$ → ohm⁻¹

⑧ Conductivity = $\frac{1}{\text{Resistivity}}$

ohm⁻¹ m⁻¹

⑨ Current density

↳ = $\frac{\text{Current}}{\text{Area}}$

(3) * Current electricity *

(1) Electric current

$I = \frac{\text{Charge}(q)}{\text{Time}(t)}$ ↳ as $q = ne$

$I = \frac{ne}{t}$

$1\,\text{ampere} = \frac{1\,\text{coulomb}}{1\,\text{second}}$

→ Current in domestic appliance = 1 A

→ Current carried by lightning = 10^4 A

→ Current in our nerves = 10^{-6} A = 1 μA

(2) Period of revolⁿ of e^-

$T = \frac{2\pi r}{v}$

(3) Frequency of revolution

$\nu = \frac{1}{T} = \frac{v}{2\pi r}$

Current (I) = Charge flowing in 1 revolⁿ × No. of revolⁿ per second

$I = e\nu = \frac{ev}{2\pi r}$

electric charge → coulomb
current → Ampere

(4) Electromotive force (emf)

$\text{emf} = \frac{\text{Work done}}{\text{charge}}$

(5) Ohm's law (At const. temp)

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

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

(*) Factor affecting the resistance

(1) Length ($R \propto l$)

(2) Area of cross sectⁿ ($R \propto \frac{1}{A}$)

(3) Nature of material ($R = \rho \frac{l}{A}$)

∴ $R = \rho$

S.I. unit of ρ = ohm meter (Ωm)

(6) Resistivity or specific resistance

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

(7) Conductance (G)

$C = \frac{1}{R}$ ↳ $M^{-1}L^{-2}T^3A^2$

↳ ohm⁻¹

(8) $\text{Conductivity} = \frac{1}{\text{Resistivity}}$

↳ ohm⁻¹ m⁻¹

(9) Current density

↳ $= \frac{\text{Current}}{\text{Area}}$

Colour code –

(Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Grey, White)

B B R O Y of Great Britain had Very Good Wife

B	B	R	O	Y	Great	Britain	Very	Good	Wife
0	1	2	3	4	5	6	7	8	9
(10^0)	(10^1)	(10^2)	(10^3)	(10^4)					(10^9)

used to evaluate resistance value of carbon resistance & its % accuracy

Some extra colour – Gold → ±5%.
Silver → ±10%.
No fourth band → ±20%.

(10) $\text{Accelerat}^n = \frac{\text{Force}}{\text{Mass}}$

(11) Drift Velocity

Avg velocity acquired by free e⁻ of conductor due to E

$V_d = \frac{eE\tau}{m}$ (E → electric field, τ → relaxat^n time, m → mass of elect^n)

(12) Current in terms of Drift velocity

$I = neAvd$

(13) Current density

$j = env_d$

Avagadro's no. = 6.023×10^{23} mol^{-1}

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

(14) Relaxat^n time (τ)

Avg time b/w 2 successive collisions

$R = \frac{ml}{ne^2\tau A}$ $10^{-14}s$

(15) Mobility (μ) magnitude (+)

Magnitude of drift velocity per unit electric field

$\mu = \frac{V_d}{E}$ (V_d → Drift velocity, E → electric field)

(16) Temperature Dependence

$T_2 > T_1$

$R_T = R_0(1 + \alpha\Delta T)$ $\alpha = K^{-1}, c^{-1}$

For metals → Resistance (R) ↑es with temp

∴ temp. cofficient (α) ↳ 4×10^{-3}

$\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)}$

$t_1 = 0°c$, $t_2 = 1°C$.

$Eg < 1ev$ (semiconductor) at room temp

$Eg \geq 1ev$ (insulator) at room temp

(17) Power → $P = I^2R$ ($P = I^2R$)

electric energy → $W = VIt$

$1kwh = 3.6 \times 10^6 J$

(18) Combinatⁿ of Resistors.

(i) In series → current same
→ voltage divides

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

(ii) In parallel → Voltage same
→ current divides

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

(*) Resistances are in ohm (Ω)

→ For 2 resistances in parallel.

$I_1 = \frac{R_2 I}{R_1 + R_2}$ & $I_2 \Rightarrow \frac{R_1 I}{R_1 + R_2}$

(19) Internal Resistance, Terminal P.d.

∴ Terminal voltage →

$V = \mathcal{E} - Ir$

∴ Terminal p.d. when cell being charged

$V = \mathcal{E} + Ir$

(20) Terminal p.d. of cell.

$V = IR = \frac{\mathcal{E}R}{R + r}$

(21) Internal resistance of a cell,

$r = R\left[\frac{\mathcal{E} - V}{V}\right]$

$\rho = R$

↓

D.F ⇒ $[ML^3T^{-3}A^{-2}]$

(22) Grouping of cells

(i) For 'n' cells in series

$I = \frac{n\mathcal{E}}{R + nr}$

$I = \frac{n\mathcal{E}}{R + nr}$

$I = \frac{n\mathcal{E}}{n + r}$

(ii) For 'n' cells in parallel.

$I = \frac{n\mathcal{E}}{nR + r}$ → no. of cells.

$I = \frac{n\mathcal{E}}{nR + r}$

(iii) Mixed grouping

$I = \frac{mn\mathcal{E}}{mR + nr}$

↳ no. of row of cells

$I = \frac{mn\mathcal{E}}{mR + nr}$

(23) Heating effect of current

$H = I^2Rt$

$H = I^2_n RT$

(24) Electric power

$P = \frac{W}{t}$

$P = \frac{W}{t}$

(25) Kirchhoff's law

(i) Junctⁿ rule.

$\Sigma I = 0$ or $I_1 + I_2 = I_3 + I_4$

(ii) Loop Rule

$\Sigma V = 0$

Current is a scalar quantity bcz of dot product

(26) Potentiometer $V \propto l$

(i) emf of 2 cells :- (based on null error; Not force; max^m p.d b/w 2 electrodes)

$$\frac{E_1}{E_2} = \frac{l_2}{l_1}$$

(ii) Internal resist. of cell:

$$r = \frac{l_1 - l_2}{l_2} \times R$$

(iii) Potential gradient:

$$K = \frac{V}{l}$$

(27) Wheat Stone bridge.

$$\frac{P}{Q} = \frac{R}{S}$$

At balance → (G) current = zero.

Unknown R ⇒ $S = \frac{Q}{P} \times R$

∴ Resistance per unit length

$$S = \frac{R(100-l)}{l}$$

(28) Resistivity (ρ)

$$\rho = \frac{SA}{l} = \frac{S \times \pi r^2}{l}$$

(29) Meter bridge

$$\frac{R}{X} = \frac{l}{100-l}$$

$S = \frac{(100-l)}{l}R$ balancing length.

Series combinat^n → Resistors connects end to end

Parallel combinat^n → Resistors connected side by side.

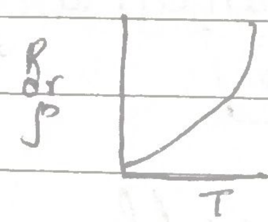
Rel^n b/w current density & drift velocity

$$\vec{J} = ne\vec{v_d}$$

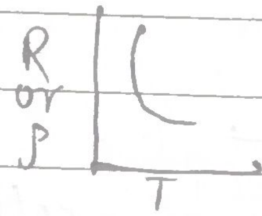
Microscopic ohm's law / (σ), J, $\vec{E}$ Rel^n.

$$\vec{J} = \sigma\vec{E}$$

α (temp. coefficient) (+ve) for Ag, Cu etc.

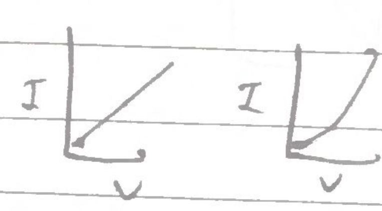


→ Conductors.



→ insulators.

Ohm's law



(Linear) (Non-linear).