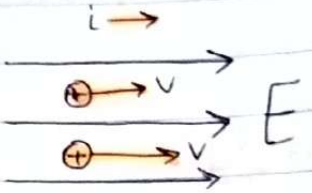
26- Current and Resistance

- Electric Current (i) :-

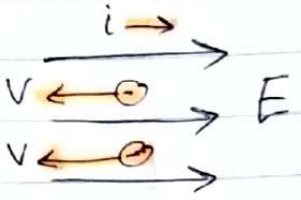
$\Rightarrow i = \frac{dq}{dt}$ c/s $\Rightarrow$ Ampere "A"



$\Rightarrow$ Current density $= \frac{i}{Area}$

$J = \frac{i}{A}$ (Ampere $/m^2$)

$i = \vec{J} \cdot \vec{A}$



- Current in a conductor :-

$\Rightarrow$ Conducting wire.

✓ Length $= \ell$

✓ cross section at Area $= A$

✓ n = number of free electrons $/m^3$

✓ $N = nA\ell$; N = number of free electron in the wire.

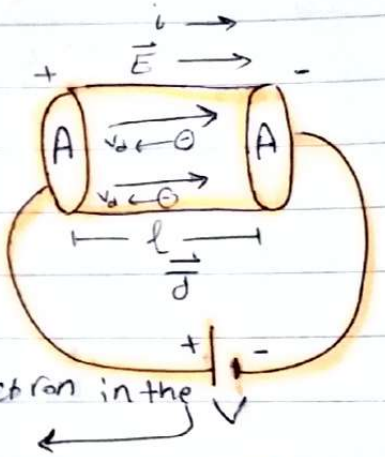
✓ free charge in the wire $= enA\ell$

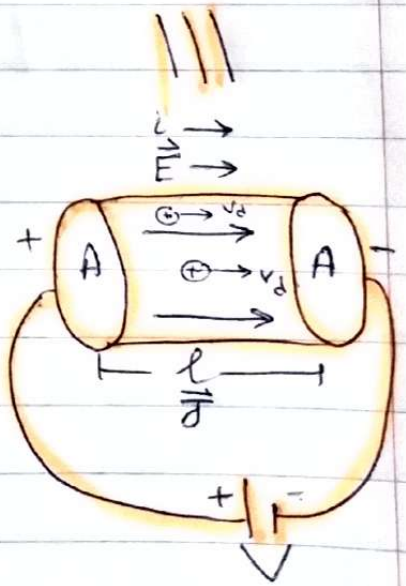
✓ $\frac{q}{\Delta t} = \frac{enA\ell}{\Delta t}$

✓ $i = enAV_d$ $\Rightarrow$ Ampere

✓ $\vec{J} = en\vec{V_d}$ $\Rightarrow$ Ampere $/m^2$

V_d; drift velocity.





- Current depends on :-

① n; the type of the conductor

② A; geometry of the conductor

③ v_d; Applied Electric field E
; Applied $V = E\ell$

- OHM's law :-

$$E \propto J$$

$$E = \rho J$$

$\frac{V}{\ell}$ ↑ E, ↓ ρ, ↑ J $= \frac{i}{A}$

ρ = resistivity

$\sigma = \frac{1}{\rho}$ conductivity

$$\Rightarrow \frac{V}{\ell} = \rho \frac{i}{A}$$

$$\Rightarrow V = \left(\frac{\rho \ell}{A}\right) i \quad \left(\frac{\rho \ell}{A} = R\right)$$

$$\Rightarrow V = Ri \qquad \Rightarrow R = \frac{V}{i} \text{ (volt/Ampere) } \Omega$$

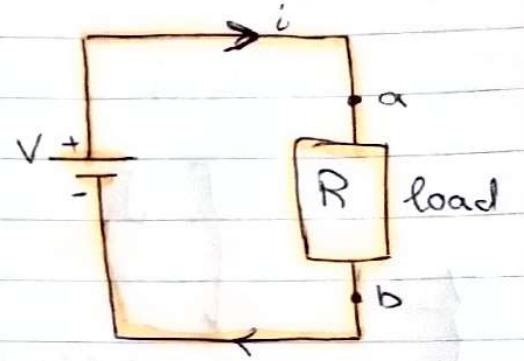
$\rho + R$ "depends on Temperature"

$$\rho - \rho_0 = \rho_0 \alpha (T - T_0)$$

$$\rho = \rho_0 [1 + \alpha \Delta T]$$

$$R = R_0 [1 + \alpha \Delta T]$$

- Power in Electric circuit:-



⇒ Energy trasfes = $(\Delta q\ V)$ J

⇒ power transfer = $\frac{\Delta q}{\Delta t} V$

J/s = watt

$$P = Vi$$

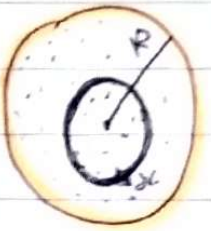
⇒ $P_{\text{thermal power}} = i^2 R$

⇒ $P_{\text{transfer}} = Vi = i^2 R = \frac{V^2}{R}$ watt

26 - 32

$\vec{J} = \alpha r^2 \quad A/m^2$

$\alpha = 2.75 \times 10^{10}$



$R = 3mm$

(a) Find i ?

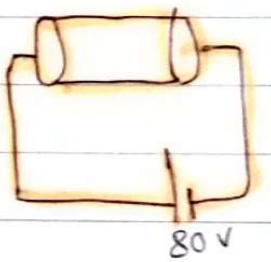
$$\Rightarrow i = \int \vec{J} \cdot d\vec{A}$$

$$i = \int_0^R \alpha r^2 (2\pi r\, dr)$$

$$= 2\pi\alpha \int_0^R r^3\, dr$$

$$= 2\pi\alpha \left(\frac{r^4}{4}\Big|_0^R\right)$$

$$\Rightarrow i = \frac{\pi}{2}\alpha R^4$$



(b) U transfer in 1 houre ?

$P_{transfer} = Vi$

$= 80 \frac{\pi}{2} \alpha R^4$ watt

$U = P \cdot t$

$= \left(80 \frac{\pi}{2} \alpha R^4 \times 3600\right)$ J