ELECTRIC CURRENT

$$q = ne$$

$$q = It$$

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

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

n = integer

e = charge of

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

q = charge

I = current, A

water flow

Equal level

No flow

V_1 V_2

$$V_1 = V_2$$

High low

Flow

V_1 V_2

$$V_1 > V_2$$

Average Current

$$I_{avg} = \frac{\Delta Q}{\Delta t}$$

$$I = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t} = \frac{dq}{dt}$$

$$A = \frac{C}{S} = CS^{-1}$$

Q8

$q = 120C$

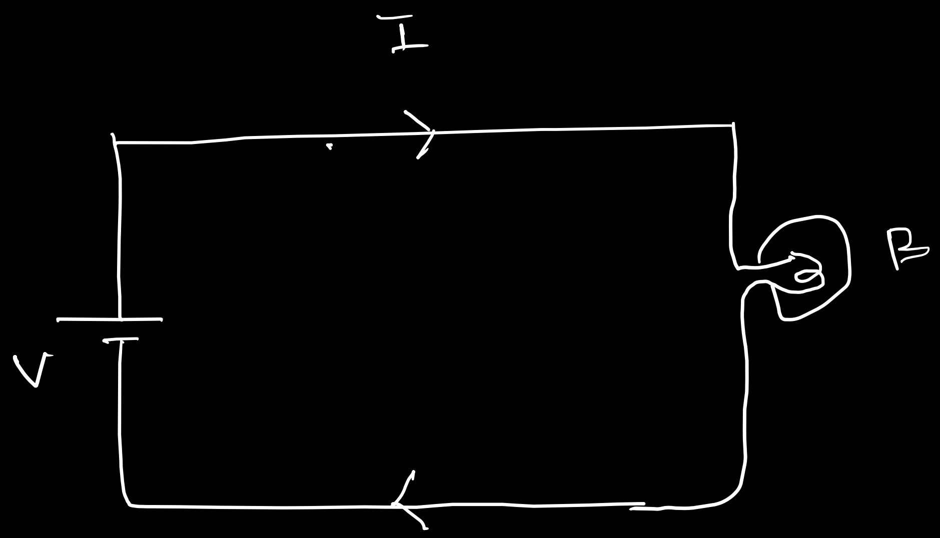
$t = 1 \text{ min} = 60s$

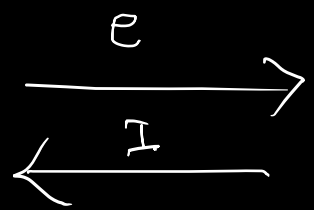
$$I = \frac{q}{t} = \frac{120}{60} \quad \frac{C}{s}$$

$$= 2\ Cs^{-1}$$

$I = 2A$ Ans

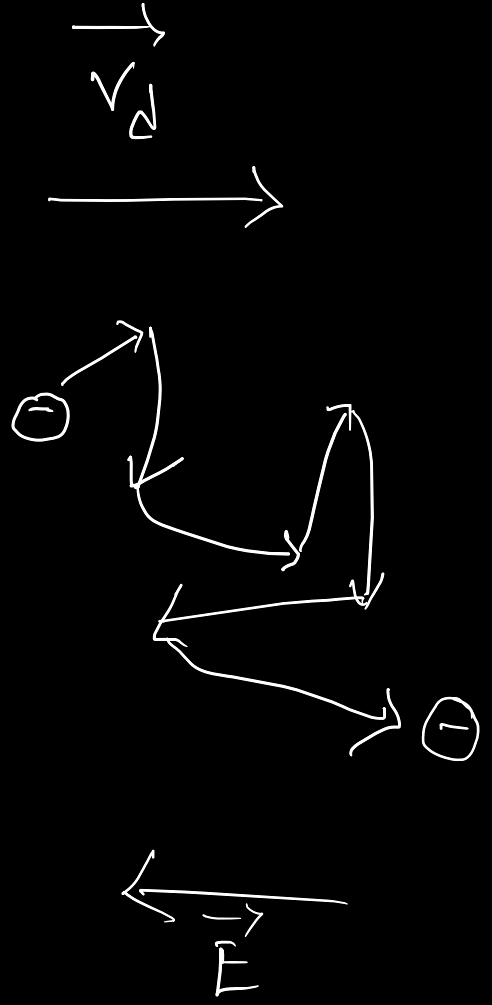
Direction of current





Drift Velocity

- There will be collisions due to zig zag movement of electrons.
- Slow motion of electrons in the conductor in a direction opposite to that of electric field vector.
- The average velocity acquired by the electrons inside the conductor when electric field is applied.
- Time between two successive collisions of electrons – mean free time. (τ)



Drift Velocity

- Acceleration is experienced by the electron in $\vec{E}$.
- $\vec{a} = \frac{-e\vec{E}}{m}$

$$\vec{V_d} = \vec{a}\tau$$

$$\vec{V_d} = \frac{-e\vec{E}}{m}.\tau$$

$$\vec{V_d} = -\frac{e\tau}{m}.\vec{E} = -\mu\vec{E}$$

e, τ, m = const.

$$\mu = \frac{e\tau}{m}$$

mobility of es

$$\mu = \frac{|\vec{V_d}|}{|\vec{E}|}$$

$F = Eq$

$F = ma$

$ma = Eq$

$m\vec{a} = -\vec{E}e$

$\vec{a} = -\frac{\vec{E}e}{m}$

$V = u + at$

$u = 0$

$V = at$

unit of μ = $m^2 V^{-1} s^{-1}$

$E = 570\ NC^{-1}$

$a = ?$

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

$m = 9.11 \times 10^{-31}\ kg$

$F = ma$

$F = eE$

$eE = ma$

$a = \frac{eE}{m}$

$$a = \frac{1.6 \times 10^{-19} \times 570}{9.11 \times 10^{-31}} \quad \frac{C \times NC^{-1}}{kg}$$

$$a = \frac{1.6 \times 570}{9.11} \times 10^{12} \quad \frac{\cancel{C} \times \cancel{kg}\,ms^{-2}\,\cancel{C^{-1}}}{\cancel{kg}}$$

$$= \frac{1.6 \times 5.7 \times 10^{14}}{9.11}$$

$$a = 1.001 \times 10^{14}\ ms^{-2}$$

Ans

Nr

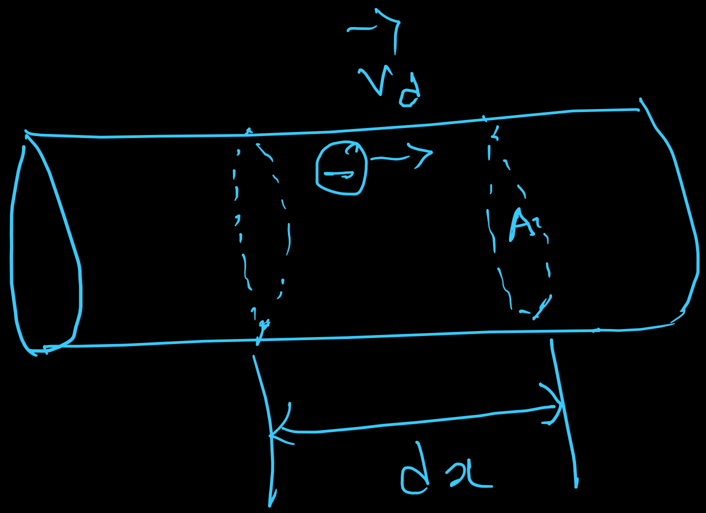
0.2041 +
0.7559

0.9600
− 0.9595

0.0005

1.001 ~~x10~~

Microscopic model of current



dt = short interval of time

A = Area of c.s. of a Conductor

dx = Short distance travelled by electron in dt

$n A \cdot dx = dV$

$v_d = \frac{dx}{dt}$

$dx = v_d \cdot dt$

$dV = A \times dx$ (area of c.s)

↑ small change in volume

n_e = no. of electrons

$\frac{n_e}{dV}$ = no. of e's per volume

$$\frac{n_e}{dV} = (A v_d \, dt)\, n$$

Total change in volume element = Charge of e × no. of $\bar{e}$s in the volume element

$$dQ = e(A v_d \, dt)\, n'$$

$$n A\, dx = dV$$

$$dx = v_d \cdot dt$$

$$I = \frac{dQ}{dt}$$

$$\frac{dQ}{dt} = e A v_d n'$$

$$\boxed{I = e A v_d n'}$$

CURRENT DENSITY (J)

$$J = \frac{I}{A}$$

unit
$J = Am^{-2}$

$$I = n'eAv_d$$

$$\frac{I}{A} = n'ev_d$$

$$J = n'ev_d$$

$$\vec{J} = n'e\vec{v}_d$$

$$\vec{v}_d = -\frac{e\tau}{m}\vec{E}$$

$$\vec{J} = -\frac{n'e^2\tau}{m}.\vec{E}$$

$$\sigma = \frac{n'e^2\tau}{m}$$

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

where σ = Conductivity

→ MICROSCOPIC OHM'S LAW

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

$$\sigma = \frac{ne^2\tau}{m}$$

$$\rho = \frac{m}{ne^2\tau}$$

ρ = resistivity

σ = conductivity

$A = 0.5\ mm^2$

$I = 0.2\ A$

$n' = 8.4 \times 10^{28}\ m^{-3}$

$n\,dV = A \cdot V_d \cdot dt \cdot n$

$n = A \cdot V_d \cdot dt \cdot \frac{n}{dV}$

$n = A \cdot V_d \cdot dt \cdot n'$

$n' = \frac{\text{no. of } e}{V} \;\Big|\; \equiv m^{-3}$

$A\,dx = dV$

$n'\,dV$

$dx = V_d \cdot dt$

$A\,V_d \cdot dt \cdot n$

$\times A$

$A\,dx = A\,V_d \cdot dt$

$dV = A \cdot V_d \cdot dt$

$\times n$