XII Physics

English Medium

Study material

Important derivations steps

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UNIT-2

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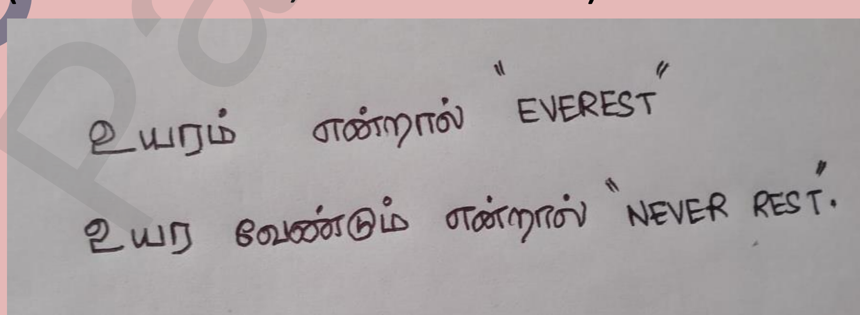

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Unit - 2

Current Electricity

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Current (I)

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

I → current.
Q → charge.
t → time.

charge = Current x time
(q (or) Q) (I) (t)

Unit:

Charge → Coulomb → C

time → second → S

Current → Ampere → A

Quantity:

Scalar Quantity.

Current density (J)

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

$$\text{Current density} = \frac{\text{Current}}{\text{cross sectional area}}$$

$$J = \frac{A}{m \times m}$$

$$J = \frac{A}{m^2}$$

$$J = Am^{-2}$$

Quantity:
Vector Quantity.

Current scalar $= \frac{Q}{t} = A$

Current density vector $\frac{I}{A} = Am^{-2}$

Current

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

$$I = \frac{C}{S} = Cs^{-1}$$

Unit: Ampere (or) Cs^{-1}

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Example 2.1

charge = 120 C
Copper wire
time = 1 minute.

Current.

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

$I = \frac{120}{60}$

$\boxed{I = 2A}$

Q = 120 C.

t = 1 minute.

= 1 x 60 seconds.

Creative Question.

charge = 120 C

copper wire

time = 1 second.

Current

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

$I = \frac{120}{1}$

$\boxed{I = 120 A}$

05-07-2022

Ohm's law.

(ஓம் விதி)

$\boxed{V = IR}$ $\boxed{I \propto V}$

R → Resistance

I → current.

V → potential difference.

(or)

Voltage.

I → current → Ampere → A

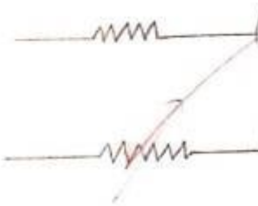
V → potential difference → volt → V

R → Resistance → ohm → Ω

R↑ I↓ I↑ V↑ I↓ V↓

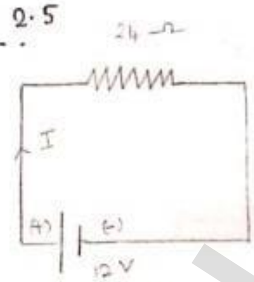
A → current → Ammeter.

V → Potential difference → voltmeter.



Pg no: 88 2m. **Example 2.5**

Soln.



$R = 24\ \Omega$

$V = 12\ V$

$I = ?$

Applying Ohm's law

$$\boxed{V = IR}$$

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

$$I = \frac{24}{12} = \frac{1}{2}$$

$$\boxed{I = 0.5\ A}$$

Pg no 86 3m **Example 2.4**

Soln.

number of electrons, $n = ?$

$t = 1\ sec$

$I = 32\ A$

Current

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

Quantisation of charge

$$\boxed{q = ne}$$

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

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

$$It = ne$$

$$n = \frac{It}{e}$$

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

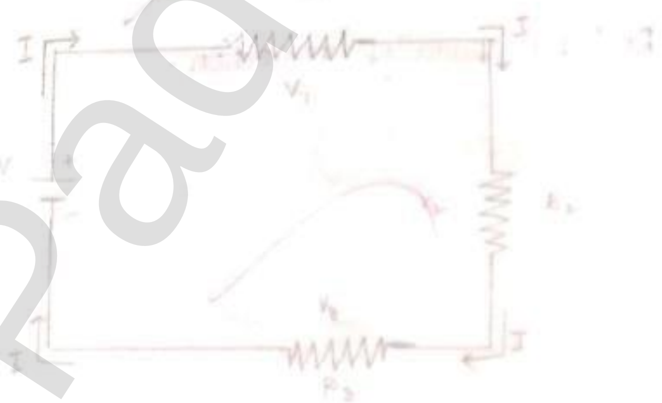
$$n = \frac{32 \times 1}{1.6 \times 10^{-19}}$$

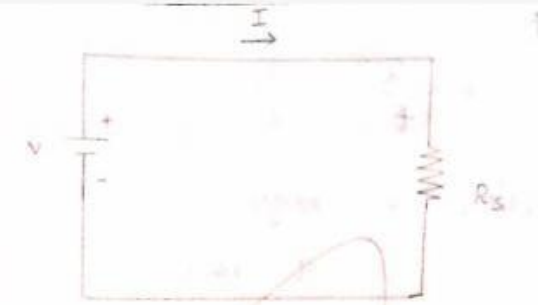
$$n = \frac{32}{1.6} \times 10^{19}$$

$$n = 20 \times 10^{19}$$

$$\boxed{n = 2 \times 10^{20} \text{ electrons}}$$

Resistor series connection





Resistor ~~para~~ Series connection.

$$V = V_1 + V_2 + V_3$$

Applying ohm's law

$$\boxed{V = IR}$$

$V_1 = IR_1$ — (1)

$V_2 = IR_2$ — (2) I → constant

$V_3 = IR_3$ — (3)

$$V = IR_1 + IR_2 + IR_3$$

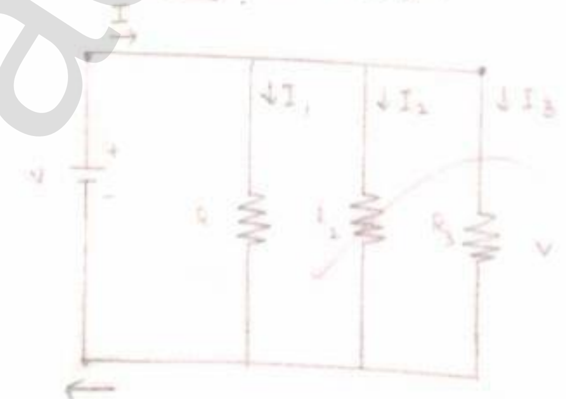
$$\boxed{V = IR_s}$$

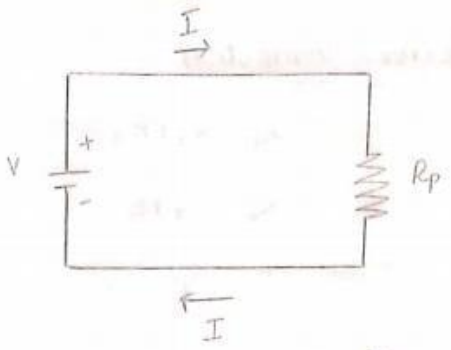
$$IR_s = IR_1 + IR_2 + IR_3$$

$$IR_s = I(R_1 + R_2 + R_3)$$

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

Resistor parallel connection.





Resistor parallel connection.

$$I = I_1 + I_2 + I_3$$

Applying ohm's law

$$V = IR$$

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

$V \rightarrow$ constant

$$I_1 = \frac{V}{R_1} \quad -(1)$$

$$I_2 = \frac{V}{R_2} \quad -(2)$$

$$I_3 = \frac{V}{R_3} \quad -(3)$$

$$I = I_1 + I_2 + I_3$$

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

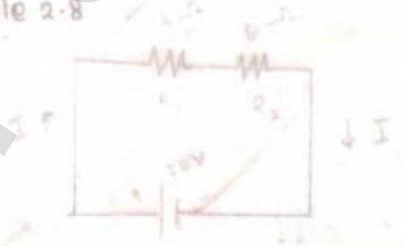
$$I = \frac{V}{R_p}$$

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

$$V\left(\frac{1}{R_p}\right) = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

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

Example 2.8



Series connection

$R_s = R_1 + R_2$

$R_s = 4 + 6$

$R_s = 10\ \Omega$

current = ?

Applying ohm's law

$V = IR$

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

$R = R_s$

$I = \frac{V}{R_s}$

$I = \frac{24}{10}$

$I = 2.4\ A$

$R_1 = 4\ \Omega$

$I = 2.4\ A$

$V_1 = IR_1$

$V_1 = 2.4 \times 4$

$V_1 = 9.6\ V$

$R_2 = 6\ \Omega$

$V_2 = IR_2$

$V_2 = 6 \times 2.4$

$V_2 = 14.4\ V$

(Resistance Increase

Potential difference increase)

Creative Question

9 Ω, 9 Ω, 9 Ω series and parallel.

Series :

$R_s = R_1 + R_2 + R_3$

$R_s = 9 + 9 + 9$

$R_s = 27\ \Omega$

Parallel :

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

$\frac{1}{R_p} = \frac{1}{9} + \frac{1}{9} + \frac{1}{9}$

$\frac{1}{R_p} = \frac{3}{9}$

$1/R_p = 1/3$

$R_p = 3\ \Omega$

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2 Ω and 4 Ω series and parallel.

Series :

$R_s = R_1 + R_2$

$R_s = 2 + 4$

$R_s = 6\ \Omega$

Parallel

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

$\frac{1}{R_p} = \frac{1}{2} + \frac{1}{4}$

$\frac{1}{R_p} = \frac{2+1}{4} = \frac{3}{4}$

$R_p = 4/3\ \Omega$

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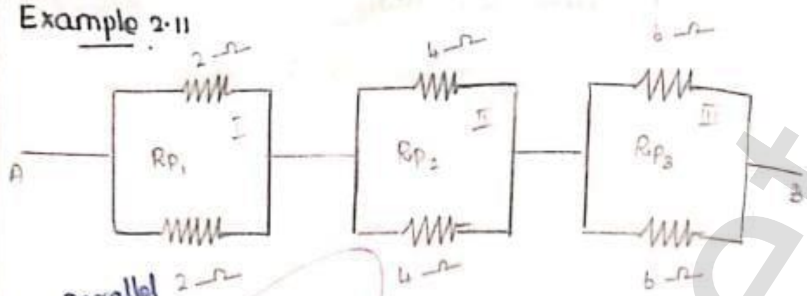
Example 2.11



Parallel

I. $\frac{1}{R_{P_1}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{P_1}} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2}$

$\frac{1}{R_{P_1}} = 1$

$R_{P_1} = 1\ \Omega$

II. $\frac{1}{R_{P_2}} = \frac{1}{R_2} + \frac{1}{R_2}$

$\frac{1}{R_{P_2}} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4}$

$\frac{1}{R_{P_2}} = 1/2$

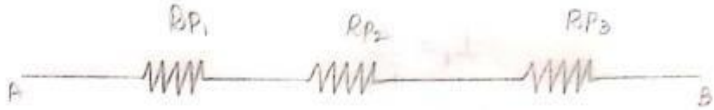
$R_{P_2} = 2\ \Omega$

III. $\frac{1}{R_{P_3}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{P_3}} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6}$

$\frac{1}{R_{P_3}} = 1/3$

$R_{P_3} = 3\ \Omega$

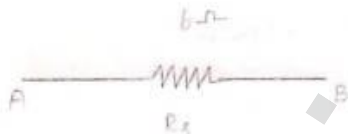


Series

$$R_s = R_{p_1} + R_{p_2} + R_{p_3}$$

$$R_s = (1+2+3)\ \Omega$$

$$\boxed{R_s = 6\ \Omega}$$



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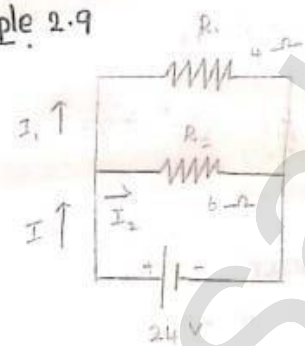
Example 2.9



Resistance parallel connection.

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

$$\frac{1}{R_p} = \frac{1}{4} + \frac{1}{6}$$

$$\frac{1}{R_p} = \frac{3+2}{12} = \frac{5}{12}$$

$$\boxed{R_p = \frac{12}{5}\ \Omega}$$

Applying ohm's law.

$$V = IR$$

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

$I_1 = \frac{V}{R_1}$

$I_1 = \frac{24}{4} = 6 A$

$I_2 = \frac{V}{R_2}$

$I_2 = \frac{24}{6} = 4 A$

Total current,

$I = I_1 + I_2$

$I = 6 + 4$

$I = 10 A$

Colour coding for resistors

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Resistor

(3) colour

(1) tolerance

1. Orange, Orange, Orange, Gold tolerance

$= 33000 \pm 5\%$

$= 33 \times 1000 \pm 5\%$

$= 33 \times 10^3 \pm 5\%$

$= 33\ k\Omega \pm 5\%$

2. Green, blue, orange, Gold tolerance.

$= 56000 \pm 5\%$

$= 56\ k\Omega \pm 5\%$

3. Blue, Gray, Red, colourless.

$= 6800 \pm 20\%$

$= 68 \times 10^2 \Omega \pm 20\%$

4. Violet, yellow, Red.

$= 7400$

$= 74 \times 10^2 \Omega \pm 20\%$

5. Blue, red, Green

$= 62 \times 10^5 \Omega \pm 20\%$

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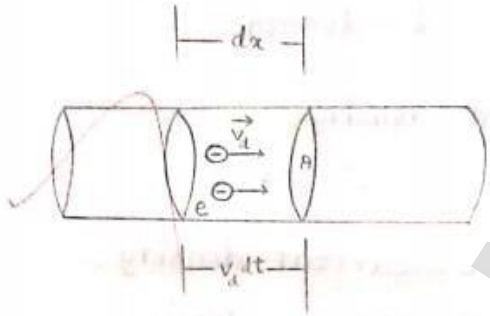
1. Microscopic model of current and Ohm's law :



Current

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

$$\boxed{dQ = nAev_d dt}$$

A → cross sectional area.
e → electron.
v_d → drift velocity.

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

$$\boxed{I = nAev_d} \quad \text{— (1)}$$

Current density :

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

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

$$\boxed{J = nev_d} \quad \text{— (2)}$$

Drift velocity :

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

$\tau \rightarrow$ Average time.
$E \rightarrow$ Electric field.
$m \rightarrow$ mass
$e \rightarrow$ electron

$$J = ne\left(-\frac{e\tau}{m} E\right)$$

$$J = -\frac{ne^2\tau}{m} E$$

$$\boxed{J = -\sigma E} \quad -③$$

Vector form.

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

conductivity :

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

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

Resistivity :

$$\rho = \frac{1}{\frac{ne^2\tau}{m}}$$

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