PARISHRAM

2026

Lecture - 01

Ch-1 ×
Ch-2 ×
Ch-3 ✓

Current Electricity

PHYSICS **LECTURE - 01**

BY - RAKSHAK SIR

Topics *to be covered*

A Electric Current

B Average and Instantaneous Current

C

D

* Syllabus for 2025-26

Class 10th → upper level

Unit II: **Current Electricity**

Chapter–3: Current Electricity (5-6 Marks)

Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, V-I characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity, temperature dependence of resistance, Internal resistance of a cell, potential difference and emf of a cell, combination of cells in series and in parallel, Kirchhoff's rules, Wheatstone bridge.

Electric Current (i)

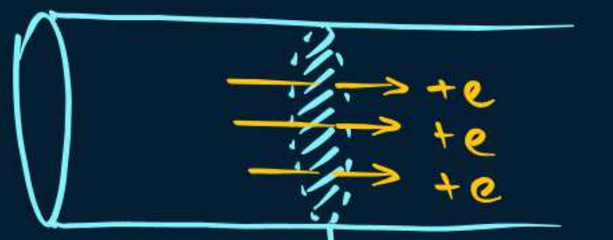
- The rate of flow of charge per unit time through a given area.
- Its direction is along the flow of positive charge.

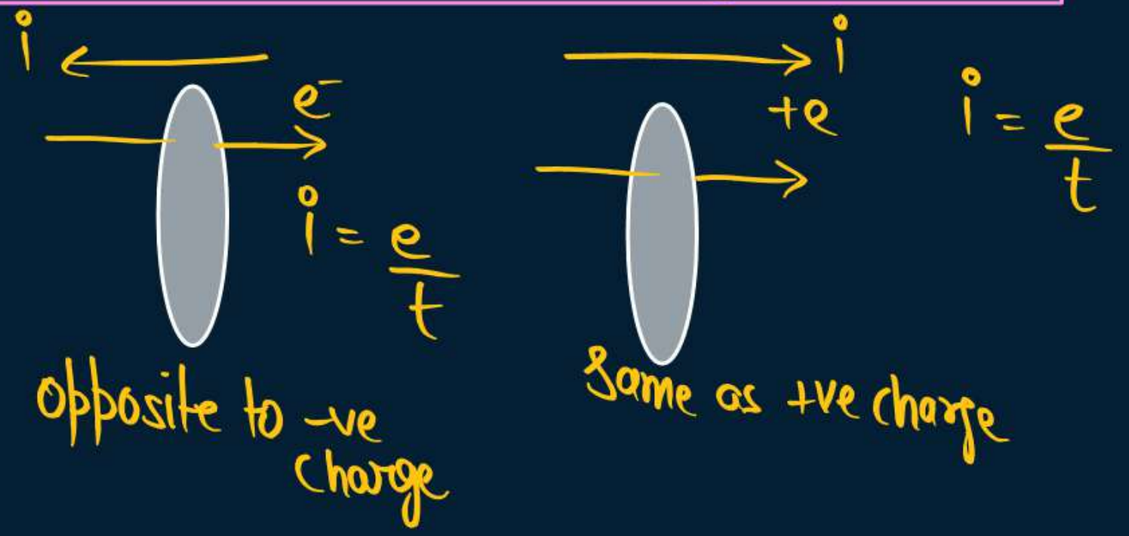
$i = \frac{q}{t}$

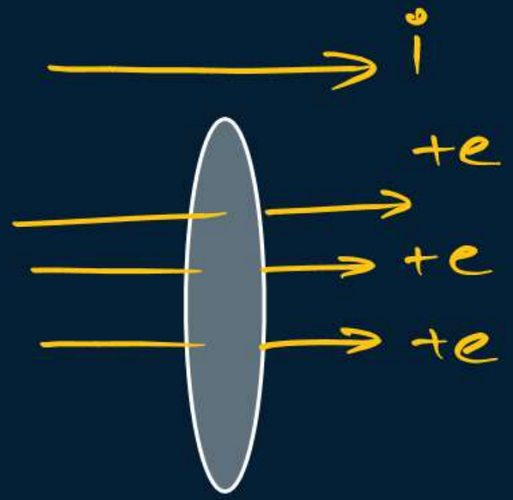
i → Ampere, q → coulomb, t → second

SI unit → Ampere or Coulomb/second

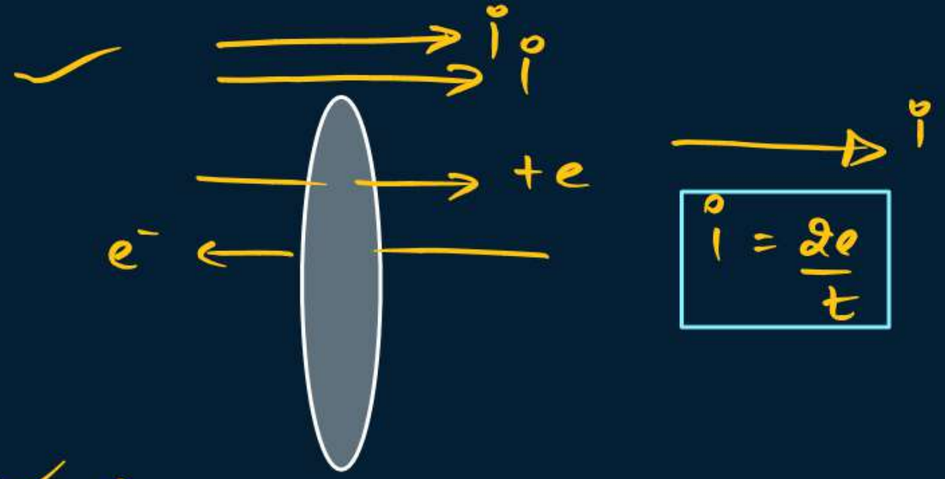
A or $\frac{C}{s}$ or Cs^{-1}



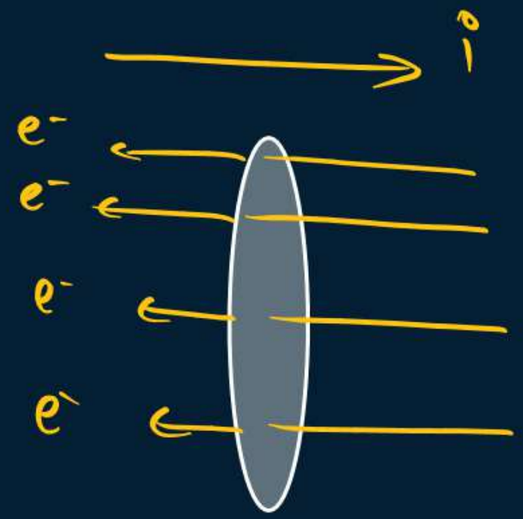




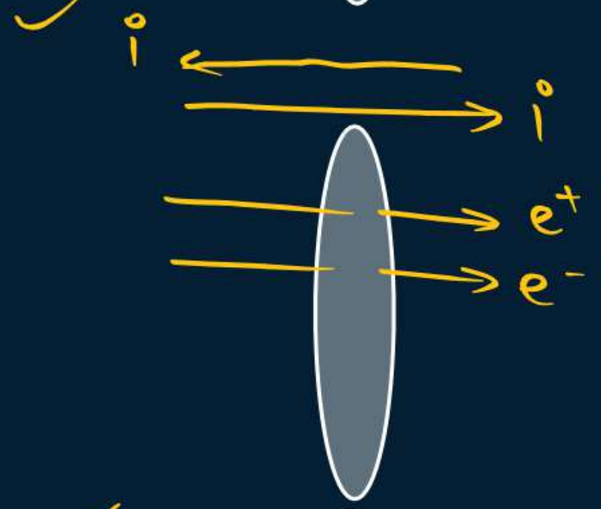
$$i = \frac{3e}{t}$$



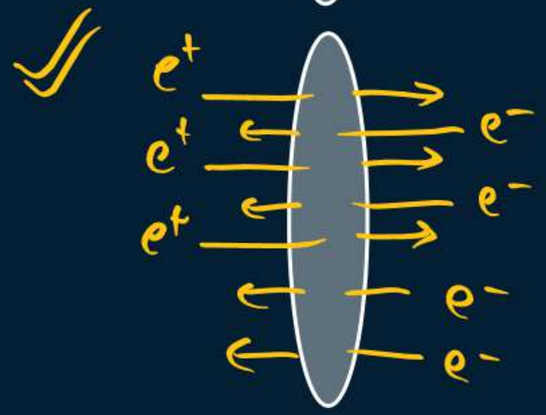
$$i = \frac{2e}{t}$$



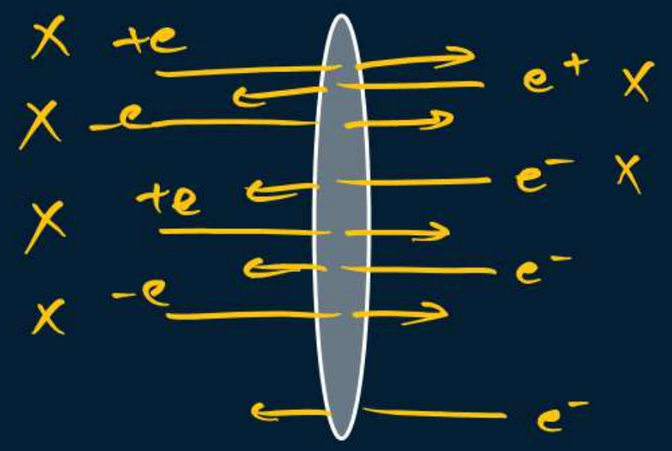
$$i = \frac{4e}{t}$$



$$i = 0$$



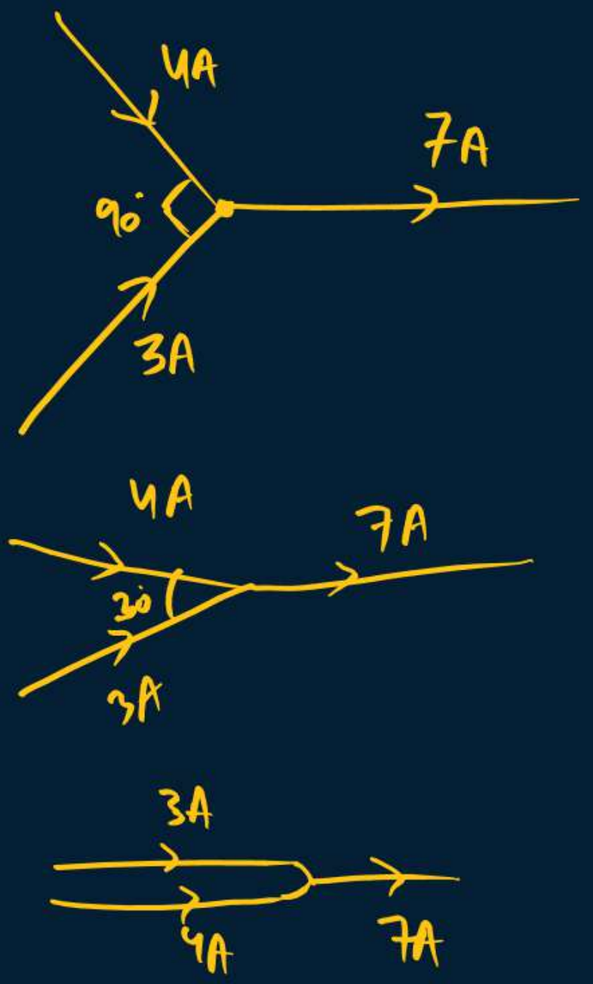
$$\left.\begin{aligned} i &= \frac{3e}{t} \\ i &= \frac{4e}{t} \end{aligned}\right\} \; i_{net} = \frac{7e}{t}$$



$$i = \frac{2e}{t}$$

Current is a scalar quantity

- Direction hai
- Magnitude hai
- But doesn't follow the laws of vector addition.



QUESTION

A current of 1 mA is flowing through a copper wire. How many electrons will pass a given point in one second [$e = 1.6 \times 10^{-19}$ Coulomb]

$n = ?$

(A) 6.25×10^{19}

(B) 6.25×10^{15}

(C) 6.25×10^{31}

(D) 6.25×10^{8}

$i = 1mA = 10^{-3}A$

$t = 1s$

$n = ?$

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

$10^{-3} = \frac{n \times 1.6 \times 10^{-19}}{1}$

$\frac{1 \times 10^{-3}}{1.6 \times 10^{-19}} = n$

$6.25 \times 10^{18} \times 10^{-3} = n$

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

$q = ne$

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

Y.K.B.

$\frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$

'1C' → 6.25×10^{18} electrons

QUESTION

Assertion: Current and charge both have direction as well as magnitude, but still are not considered vector.

Reason: They do not follow laws of vector addition.

(A) Both assertion and reason are correct and reason is correct explanation of assertion.

(B) Both assertion and reason are correct and reason is not the correct explanation of assertion.

(C) Assertion is correct, reason is incorrect

(D) Assertion is incorrect, reason is correct

Average and Instantaneous Current

for a time interval (Δt)

$$i_{av} = \frac{\Delta q}{\Delta t}$$

$$\boxed{i_{av} = \frac{q_2 - q_1}{t_2 - t_1}}$$

dt

$$\boxed{i = \frac{dq}{dt}}$$

$$\boxed{\int dq = \int i \cdot dt}$$

Y.K.B.

RDx :-

$$x \underset{\int}{\overset{d}{\rightleftarrows}} v \underset{\int}{\overset{d}{\rightleftarrows}} a$$

$$q \underset{\int}{\overset{d}{\rightleftarrows}} i$$

Y.K.B.

$$V_{av} = \frac{\Delta x}{\Delta t}$$

$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{v-u}{t}$$

$$F_{av} = \frac{\Delta p}{\Delta t}$$

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

$$a = \frac{dv}{dt}$$

$$F = \frac{dp}{dt}$$

QUESTION

Charge through a cross-section of a conductor is given by $Q = (4t^2 + 5)C$. Find the current through the conductor at the instant $t = 2$ s.

$$Q = (4t^2 + 5)\,C$$

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

$$i = \frac{d(4t^2+5)}{dt}$$

$$i = 4(2t) + 0$$

$$\boxed{i = 8t}$$

$$i = \frac{dq}{dt}$$

$$i = 8t$$

put $t = 2s$

$$i = 8 \times 2$$

$$\boxed{i = 16A}$$

QUESTION

Charge through a cross-section of a conductor is given by $Q = (4t^2 + 5)C$. Find the average current through the conductor at the instant in the interval $t_1 = 1$ to $t_2 = 3$ sec.

$$q = (4t^2 + 5)\,C$$

$$i = \frac{\Delta q}{\Delta t}$$

$t_1 = 1s$, $q_1 = 4(1)^2 + 5 = 9C$

$t_2 = 3s$, $q_2 = 4(3)^2 + 5 = 41C$

$$i = \frac{q_2 - q_1}{t_2 - t_1}$$

$$= \frac{41 - 9}{3 - 1} = \frac{32}{2} = 16A$$

$$\boxed{i = 16A}$$

QUESTION

JEE 2024

Current through a cross-section of a conductor is given by $i = (2t + 3)$ A. Find the charge flow through the conductor in the interval $t = 0$ to $t = 2$ sec.

$\Delta q = ?$

$i = (2t+3)\,A$

$t_1 = 0$

$t_2 = 2s$

$q \xrightleftharpoons[\int]{d} i$

$i = \frac{dq}{dt}$

$\frac{dq}{dt} = 2t+3$

$dq = (2t+3)\cdot dt$

integrating both side

$\int_{q_1}^{q_2} dq = \int_{t_1}^{t_2} (2t+3)\cdot dt$

$[q]_{q_1}^{q_2} = \left[\cancel{2}\frac{t^2}{\cancel{2}} + 3t\right]_{t_1=0}^{t_2=2}$

$q_2 - q_1 = [t^2 + 3t]_0^2$

$q_2 - q_1 = [2^2 + 3(2)] - [0^2 + 3(0)]$

$\Delta q = [4+6] - 0$

$\boxed{\Delta q = 10C}$ Ans

QUESTION

Current through a cross-section of a conductor is given by $i = (2t + 3)$ A. Find the average through the conductor in the interval $t = 0$ to $t = 2$ sec.

Current

$i = (2t+3)A$

$t_1 = 0s$

$t_2 = 2s$

$$\boxed{i_{av} = \frac{\int i.dt}{\Delta t} \quad \text{OR} \quad i_{av} = \frac{(\Delta q)}{\Delta t}}$$

$$= \frac{(q_2 - q_1)}{t_2 - t_1}$$

$$= \frac{(q_2 - q_1)}{2 - 0}$$

$$= \frac{10}{2} = 5A \text{ Ans}$$

QUESTION

H.W.

Electric current through a conductor varies with time as $i = at^2$ where a is a constant. Total charge flown through a cross-section in time $t_1 = 0$ to $t_2 = 2$ sec is

$\Delta q = ?$

(A) $\frac{a \times 8}{5}$ unit

(B) $\frac{a \times 8}{7}$ unit

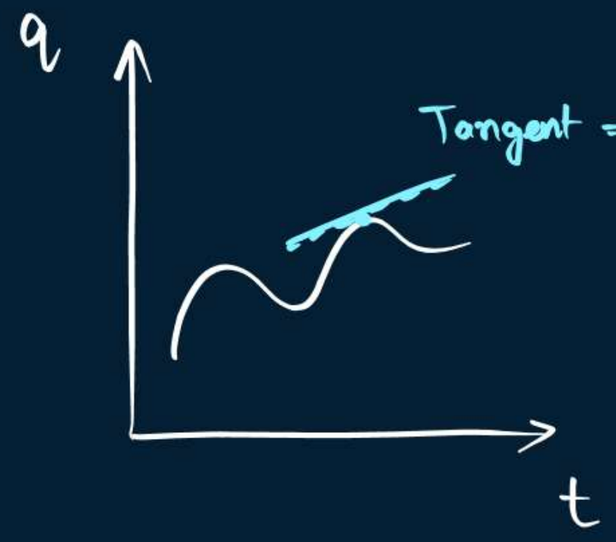
(C) $\frac{a \times 8}{3}$ unit

(D) $\frac{a \times 8}{1}$ unit

Graphs

$(q-t) \xrightarrow{\text{slope}} i$

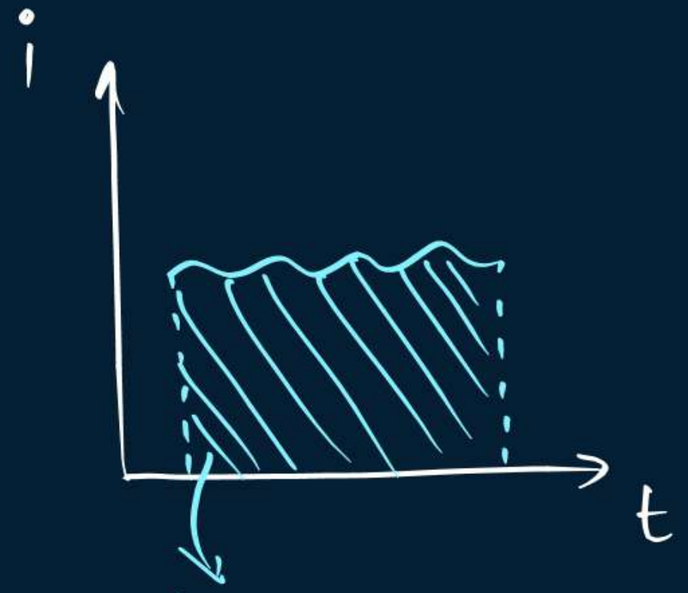
$(i-t) \xrightarrow{\text{Area}} \Delta Q$



Tangent = $\boxed{\text{slope} = \tan\theta = i}$

Slope $(y-x)$ $= \dfrac{dy}{dx}$

$$\boxed{\text{Slope } (q-t) = \frac{dq}{dt} = i}$$



Area under graph $(y-x)$ $= \int y \cdot dx$

$(i-t)$ $= \int i \cdot dt = \Delta Q$

$\downarrow$

Charge flow

QUESTION

The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure. What is the value of current at $t = 4$ s ? [JEE Main 2019]

(A) 3 μA

(B) 2 μA

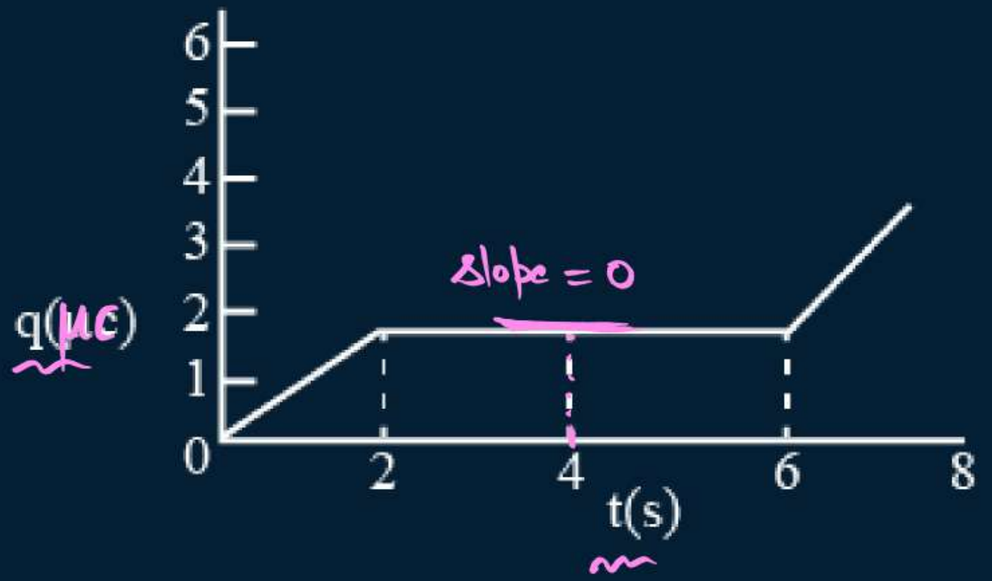
(C) zero

(D) 2 μA

$\text{slope}_{(q-t)} = \frac{dq}{dt} = i$

$\frac{dq}{dt} = 0$

$i = 0$



QUESTION

The plot represents the flow of current through a wire at three different times. The ratio of charges flowing through the wire at different times is (See figure).

(A) 2 : 1 : 2

(B) 1 : 3 : 3

(C) 1 : 1 : 1

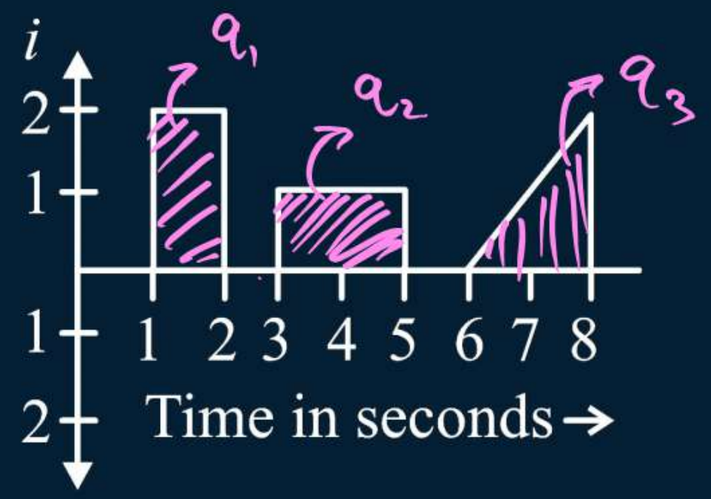
(D) 2 : 3 : 4

$q_1 : q_2 : q_3$

$2\times1 : 2\times1 : \frac{1}{2}\times2\times2$

$q : q : q$

$1 : 1 : 1$



QUESTION

NOTES

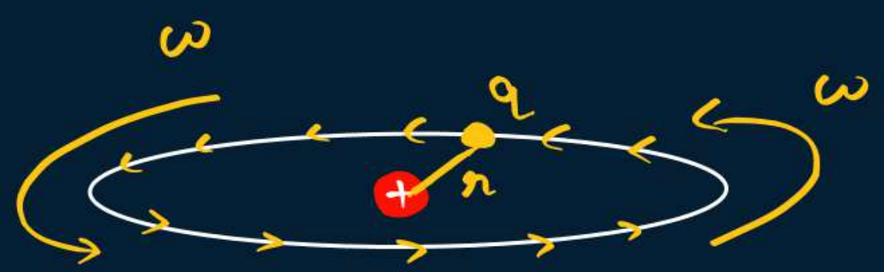
$\omega = \frac{2\pi}{T} \rightarrow T = \frac{2\pi}{\omega}$ | $V = r\omega \rightarrow \omega = \frac{V}{r}$

A charge is revolving in a circle of radius *r* with angular speed ω. Find current in the circuit.

$\frac{1}{T} = \nu$

Current = $\frac{\text{Charge}}{\text{Time Period}}$

$$i = \frac{q}{T}$$



$$i = \frac{q}{\frac{2\pi}{\omega}}$$

$$i = \frac{q\omega}{2\pi} \Rightarrow i = \frac{qv}{2\pi r}$$

$$i = \frac{q}{T} = q\left(\frac{1}{T}\right)$$

$$i = q\nu$$

Homework

- Notes
- H.W.
- Assignment ch-2

PARISHRAM

2026

Lecture - 02

Current Electricity

PHYSICS **LECTURE - 2**

BY - RAKSHAK SIR

Topics *to be covered*

- A Ohm's Law
- B Factors affecting Resistance
- C
- D

HW QUESTION

Electric current through a conductor varies with time as $i = at^2$ where a is a constant. Total charge flown through a cross-section in time $t_1 = 0$ to $t_2 = 2$ sec is

(A) $\frac{a \times 8}{5}$ unit

(B) $\frac{a \times 8}{7}$ unit

(C) $\frac{a \times 8}{3}$ unit

(D) $\frac{a \times 8}{1}$ unit

$i = at^2$

$\int dq = \int i \cdot dt$

$\Delta Q = ?$

$\frac{dq}{dt} = at^2$

$\int dq = \int at^2 \cdot dt$

$\Delta Q = a\int_0^2 t^2 \cdot dt$

$= a\left[\frac{t^3}{3}\right]_0^2$

$= a\left[\frac{2^3}{3} - \frac{0^3}{3}\right]$

$= \frac{a \times 8}{3}$

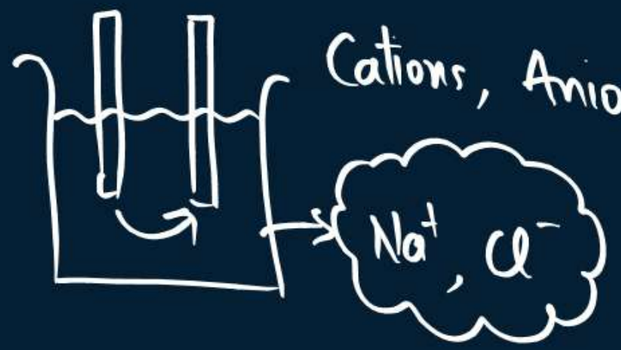
Current in different materials

Charge carriers

This Chapter ← ① Conductor → electrons (e^-) ki Bhaarmaar

Last Chapter ← ② Semi-conductors → electrons (e^-), holes (+)

Electro Chemistry ← ③ Electrolytes



Cations, Anions

human Body Nerves = μA
= 10^{-6} A

→ mA or μA

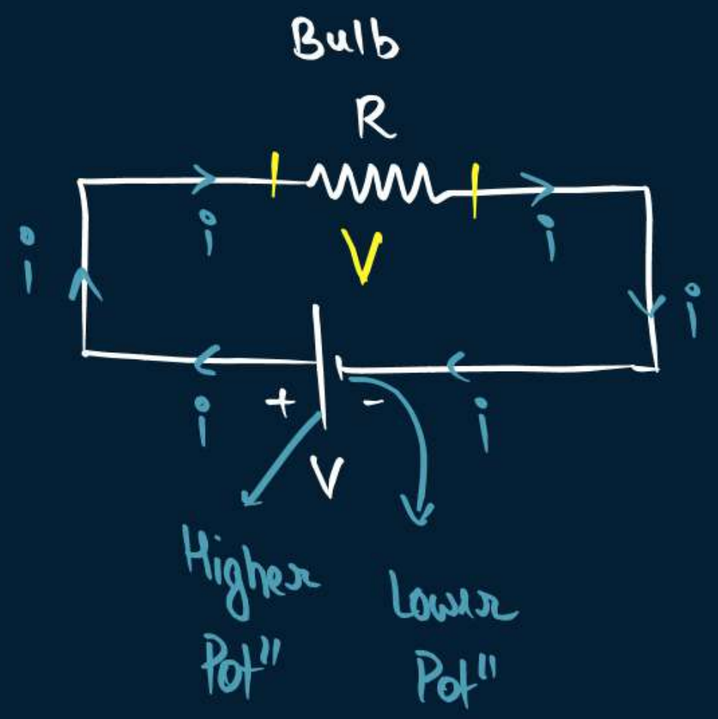
$$I_{net} = I_h + I_e$$

Ohm's Law for current in conductors

$V = IR$

$V \propto I$ → ohm's law

The current in conductor is directly proportional to the potential difference (voltage) applied, provided external conditions like temperature etc. remain constant.



$V \propto I$

$V = IR$

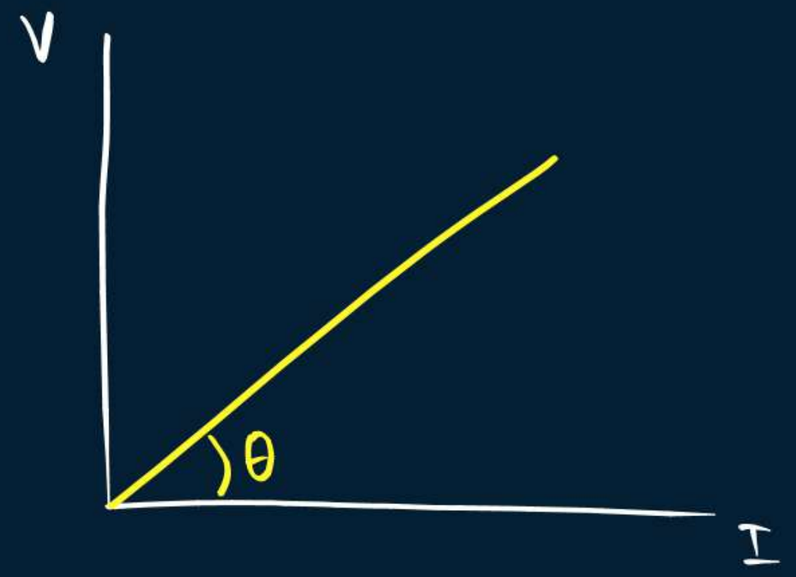
Voltage, Current, Resistance

$$R = \frac{V}{I} = \frac{2V}{2I} = \frac{3V}{3I} = \frac{10V}{10I}$$

NOTE -

R is independent of V or I.

Slope of graph (V-I) = 'R'



$$\boxed{m = \text{slope} = \tan\theta = R}$$

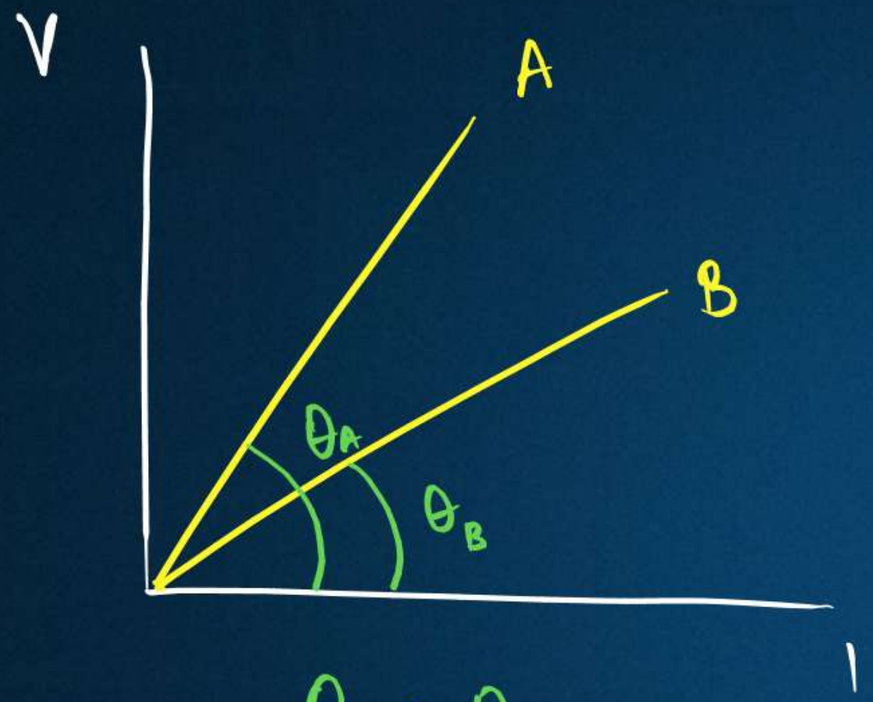
m , c

Slope - intercept form of a line :-

$$y = mx + c$$

$$V = RI + 0$$

Always $C = 0$, origin

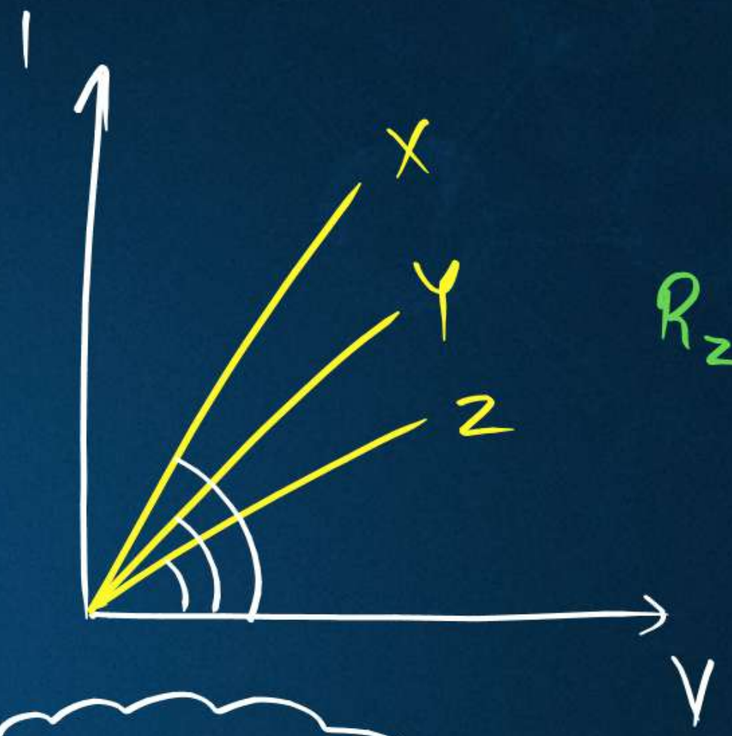


$$\theta_A > \theta_B$$

$$\tan\theta_A > \tan\theta_B$$

$$m_A > m_B$$

$$R_A > R_B$$

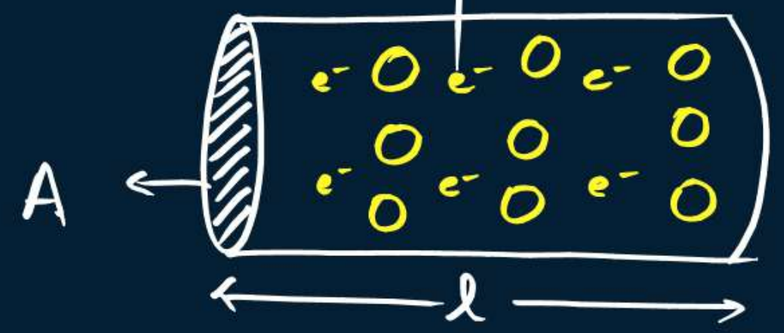


$$R_Z > R_Y > R_X$$

$$\text{Slope}\uparrow_{(I-V)} = \frac{1}{R\downarrow}$$

Dependence of resistance on various factors

→ Material : Resistivity (ρ) = Constant for a given material



i) $R \propto l$

ii) $R \propto \frac{1}{A}$

$R \propto \frac{l}{A}$

l → length of the wire (m)

A → Cross-sectional Area (m^2)
(Area of Circle = πR^2)

ρ → Resistivity (Ω-m)

T → Temperature (°C or K)

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

ρ → Constant of Proportionality

* Meaning and feel of 'ρ'

- Resistivity ka Matlab hota hai rok paane ki ksmta Current ko.
- Depends on material and Temp.

$\rho \uparrow$ Insulator Acha hoga

(Silver) $\rho \downarrow$ conductor Acha hoga. (ρ least)

Units and Dimensions

Units :-

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

ohm = 'ρ' $\frac{\cancel{\text{metre}}}{\cancel{\text{metre}} \times \text{metre}}$

Ohm-meter = 'ρ'

$\boxed{\Omega\text{-}m = \text{'}\rho\text{'}}$

Dimensional formula

$V = IR$

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

$= \frac{[ML^2T^{-3}A^{-1}]}{[A]}$

$\boxed{[R] = [ML^2T^{-3}A^{-2}]}$

$R = \rho \frac{l}{A} \rightarrow \rho = \frac{RA}{l} = \frac{[ML^2T^{-3}A^{-2}][L^2]}{\cancel{[L]}} = \boxed{[ML^3T^{-3}A^{-2}]}$

$U = qV$

$V = \frac{U}{q}$ $\rightarrow [ML^2T^{-2}]$, $q \rightarrow [AT]$

$\boxed{[V] = [ML^2T^{-3}A^{-1}]}$

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

$q = it$

$= [A][T]$

$\boxed{[q] = [AT]}$

QUESTION

$\rho\uparrow$ insulator
$\rho\downarrow$ conductor

G.K.

Consider four conducting materials copper, tungsten, mercury and aluminium with resistivity ρ_C, ρ_T, ρ_M and ρ_A respectively. Then

[2 Sep, 2022 (S-I)]

(A) $\rho_A > \rho_T > \rho_C$

(B) $\rho_M > \rho_A > \rho_C$

$\rho_M > \rho_T > \rho_A > \rho_C$

(C) $\rho_C > \rho_A > \rho_T$

(D) $\rho_A > \rho_M > \rho_C$

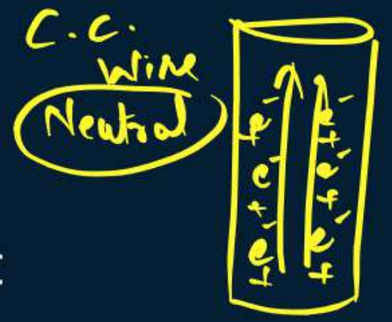
QUESTION

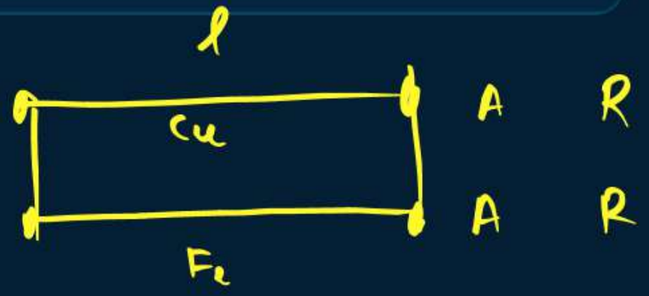
Diff. $R = S\frac{l}{A}$ Diff.

True

Statement-I: It is not possible to construct two wires of the same length and same area, one of copper and the other of iron, such that they have the same resistance at the same temperature.

Statement-II: A current-carrying wire is electrically charged. → False





(A) Both statement-I and II are correct

(B) Both Statement-I and II are incorrect

(C) Statement-I is correct and Statement-II is incorrect

(D) Statement-I is incorrect and Statement-II is correct

Wire stretched or Compressed / Melt and recast / drawn-out $\Rightarrow V = \text{const.}$

$A \rightarrow$ Area of circle

$A = \pi r^2$ ✓

$r \rightarrow nr$

$d \rightarrow nd$

$A \rightarrow n^2 A$

Imp.

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

$R = \rho \frac{V}{A^2}$

$V \rightarrow$ const., $\rho \rightarrow$ const.

$R \propto \frac{1}{A^2}$

$A \rightarrow nA$

$R \rightarrow \frac{R}{n^2}$

$r \rightarrow nr, d \rightarrow nd$

$R \rightarrow \frac{R}{n^4}, R \rightarrow \frac{R}{n^4}$

Imp.

$R = \rho \frac{l}{A} \times \frac{l}{l}$, $R = \frac{\rho l^2}{V}$

$V \rightarrow$ const.

$\rho \rightarrow$ const.

$R \propto l^2$

$l \rightarrow nl$

$R \rightarrow n^2 R$

QUESTION

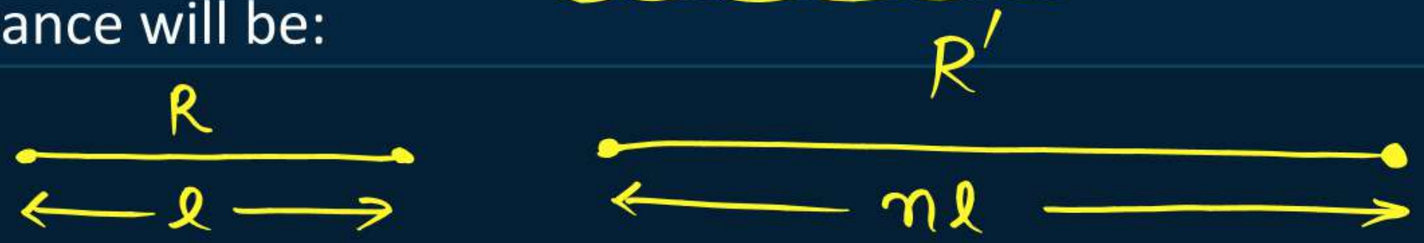
The resistance of a wire is 'R' ohm. If it is melted and stretched to '*n*' times its original length, its new resistance will be: [2017]

(A) R/*n*

(B) n^2R

(C) R/n^2

(D) *n*R



$l \rightarrow nl$

$R \rightarrow n^2R$

Case - I

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

$R = \frac{\rho l^2}{V}$ ---(I)

Case - II

$R' = \rho \frac{l}{A} \times \frac{l}{l}$

$R' = \frac{\rho l'^2}{V}$ ---(II)

Divide (I) by (II)

$\frac{R}{R'} = \frac{\frac{\rho l^2}{V}}{\frac{\rho l'^2}{V}}$

$\frac{R}{R'} = \left(\frac{l}{l'}\right)^2$

$\frac{R}{R'} = \left(\frac{l}{nl}\right)^2$

$\frac{R}{R'} = \frac{1}{n^2}$

$R' = n^2R$

QUESTION

A wire of resistance 4 Ω is stretched to twice its original length. The resistance of stretched wire would be [2013]

(A) 4 Ω

(B) 8 Ω

(C) 16 Ω

(D) 2 Ω

$l \rightarrow 2l$

$R \rightarrow 2^2 R$

$\Rightarrow 4 \times R$

$\Rightarrow 4 \times 4$

$= 16\Omega$

$l \rightarrow nl$

$R \rightarrow n^2 R$

QUESTION

The resistivity of iron is 1×10^{-7} ohm-m. The resistance of iron wire of particular length and thickness is 1 ohm. If the length and the diameter of wire both are doubled, then the resistivity in ohm-m will be:

ρ

→ independent l, A ..

→ depends on material, Temp.

(A) 1×10^{-7}

(B) 2×10^{-7}

(C) 4×10^{-7}

(D) 8×10^{-7}

QUESTION

A uniform wire of resistance R is uniformly compressed along its length until its radius becomes n times the original radius, now resistance of the wire becomes [Module]

(A) $\frac{R}{n^2}$

(B) $\frac{R}{n^4}$

(C) $\frac{R}{n}$

(D) nR

$r \to nr$

$A \to n^2 A$

$R \to \frac{R}{n^4}$

$3^4 = 3\times3\times3\times3$
$= 9\times9$
$= 81$

$2^4 = 2\times2\times2\times2$
$= 4\times4$
$= 16$

Practice Ques

$r \to 2r$

$A \to 4A$

$R \to \frac{R}{16}$

Pehle	Baad me
$r = 1m$	$\xrightarrow{\times 3}$ $r = 3m$
$A = \pi \cdot 1 \times 1$	$A = \pi \cdot 3 \cdot 3$
$A = \pi$	$\xrightarrow{\times 3^2}$ $A = 9\pi$
$R = \frac{\rho V}{A^2}$	$R = \frac{\rho V}{A^2}$
$R = \frac{\rho V}{\pi^2}$	$\xrightarrow{\frac{1}{3^4}}$ $R = \frac{\rho V}{(9\pi)^2}$
	$R = \frac{\rho V}{81\pi^2}$

QUESTION

% change in l = $\frac{\Delta l}{l} \times 100 = 0.5\%$

A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is [JEE Main 2019]

(A) 2.5%

(B) 0.5%

(C) 1.0%

(D) 2.0%

$R = \frac{\rho l^2}{V}$

$\rho, V \rightarrow$ Const.

$R \propto l^2$

$\frac{\Delta R}{R} = 2\frac{\Delta l}{l}$

$\left(\frac{\Delta R}{R} \times 100\right) = 2 \times \left(\frac{\Delta l}{l} \times 100\right)$

$\frac{\Delta R}{R} \times 100 = 2 \times 0.5\% = 1\%$

Y.K.B.

Class-11 Errors

"Small changes"

$x \propto y^n$ 7%

$\frac{\Delta x}{x} = n\frac{\Delta y}{y}$

QUESTION

$\frac{\Delta l}{l} \times 100 = 0.7\%$

A copper wire is stretched to make it 0.7% longer. The percentage change in its electrical resistance if its volume remains unchanged is

$R \propto l^2$

$R \propto l^2$

(A) Increase by 0.35 %

(B) Increase by 1.4 %

(C) Decrease by 0.35 %

(D) Decrease by 1.4 %

$\frac{\Delta R}{R} \times 100 = 2\left(\frac{\Delta l}{l} \times 100\right)$

$= 2 \times 0.7$

$= 1.4\%$

QUESTION

$\cancel{\frac{\Delta l}{l} \times 100}$

The length of a given cylindrical wire is increased by 100 %. Due to the consequent decrease in diameter, the change in resistance of the wire will be [Module]

(A) 200 %

(B) 100 %

(C) 50 %

(D) 300 %

$l \longrightarrow 2l$

$R \longrightarrow 2^2 R$

$R \longrightarrow 4R$

$l \rightarrow nl$

$R \rightarrow n^2 R$

RDX

$$\boxed{\%\Delta = \frac{F - I}{I} \times 100}$$

$$\%\Delta R = \frac{R_f - R_i}{R_i} \times 100$$

$$\frac{4R - R}{R} \times 100$$

$$\frac{3\cancel{R}}{\cancel{R}} \times 100 = 300\%$$

QUESTION

A wire of a certain material is stretched slowly by 10 percent. Its resistance changes by

(A) 10 %

(B) 20 %

(C) 21 %

(D) 12 %

7%

$l \rightarrow l + 10\%$ of l

$\rightarrow l + \frac{10}{100} l$

$\rightarrow l\left(1 + \frac{1}{10}\right)$

$\rightarrow l(1 + 0.1)$

$l \rightarrow 1.1 l$

$l \rightarrow n l$

$R \longrightarrow n^2 R$

$R \longrightarrow (1.1)^2 R$

1.21

$\% \Delta R = \frac{R_f - R_i}{R_i} \times 100$

$= \frac{(1.1)^2 R - R}{R} \times 100$

$= \frac{R}{R}\left[(1.1)^2 - 1\right] \times 100 = (1.21 - 1) \times 100$

$= 0.21 \times 100$

$= 21\%$

Homework

- Practice All Ques Again..
- Notes...
- Revision

PARISHRAM

2026

Lecture - 03

Current Electricity

PHYSICS **LECTURE - 3**

BY - RAKSHAK SIR

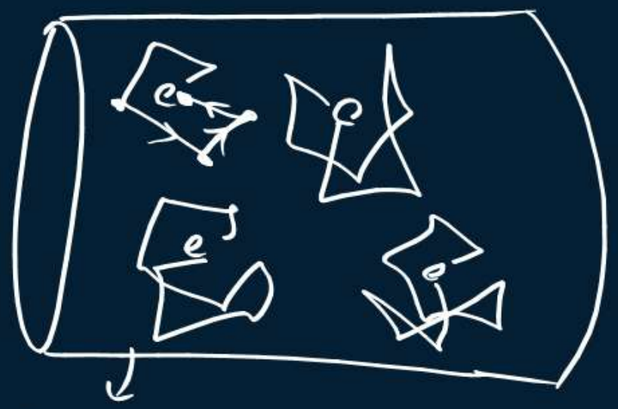
Topics *to be covered*

- A Drift Velocity
- B Temperature Dependence and Graphs
- C
- D

Electric Current in Conductors (Microscopic Analysis)

Isolated Conductor – Not connected to the battery

'Alone'



Conductor → free electrons

⇓

(Random Thermal Motion) → $I = 0$, $V_{avg} = 0$

n → number density of free e^-

$$n = \frac{\text{Number of free electrons}}{\text{Volume}}$$

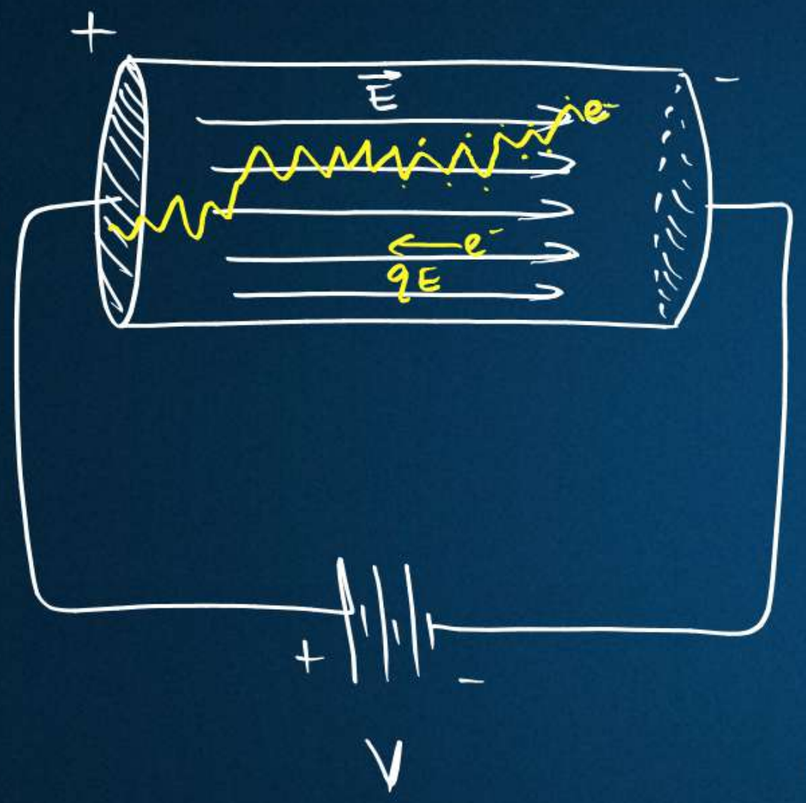
$$n = \frac{N}{V}$$

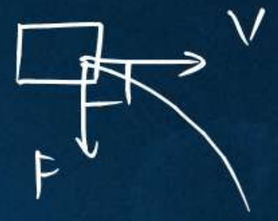
$10^{28}/m^3$ * याद

$10^{29}/m^3$

- The free electrons move in zig-zag manner due to random thermal motion.
- The random thermal motion is due to the temperature.
- An electron can collide with other electrons and stationary atoms. ⇒ Cause of Resistance
- The path between two collisions in absence of battery is straight line.
- The random thermal speed is of the order of 10^5 m/sec at normal temperature.
- Due to random motion, the net effect of all the electron motion is zero. $V_{avg} = 0$
- Overall the value of current when battery is not connected is zero. $i = 0$

What if Battery is connected





→ e^- are drifted towards +ve end of the conductor.

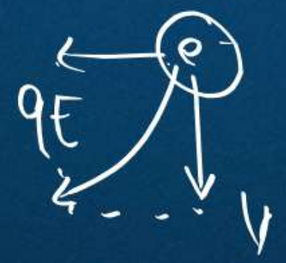
↳ e^- ka path May be curvilinear

$F = qE$

$\vec{F} = -e\vec{E}$

$V_{avg} \neq 0$

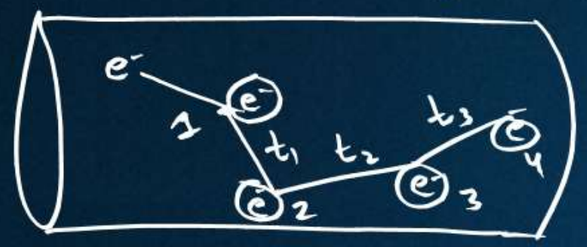
$i \neq 0$



Relaxation time (τ) & Drift Velocity (V_d)

$\tau \rightarrow (10^{-14}\,s)$

$V_d \rightarrow (10^{-4}\,m/s)$ → order of Magnitude $(10^{-5}\,m/s)$



The Average time between two successive collisions during the motion of a free electron

$$\boxed{\tau = \frac{t_1 + t_2 + t_3 + \dots t_n}{n}}$$

Seconds

The average velocity of a free electron when it is drifted towards positive end of a conductor connected to a battery

$$V = u + at$$

$$V = 0 + \left(-\frac{eE}{m}\right)\tau$$

$$\boxed{V = -\frac{eE}{m}\tau}$$

$$V = a\tau$$

$$F = qE \quad \dots (1)$$

$$F = ma \quad \dots (2)$$

$$qE = ma$$

$$-eE = ma$$

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

QUESTION

The drift speed depends on time.

Any time

$V_d = \frac{eE\tau}{m}$

(A) True

(B) False

(C) Kya Pta !!

QUESTION

Order of average relaxation time of free electrons in metallic conductor is

A. 10^{-8} sec

B. 10^{-14} sec

C. 10^{-18} sec

D. 10^{-3} sec

QUESTION

Match the Column-I with Column-II.

	Column-I		Column-II
A.	Average velocity of free electrons in metals when $E = 0$	P.	10^5 ms^{-1}
B.	Random velocity of free electrons in metals when $E = 0$	Q.	10^{-5} ms^{-1}
C.	Drift velocity of free electrons in metals when $E \neq 0$	R.	0 ms^{-1}

(A) A-(R); B-(P); C-(Q)

(B) A-(P); B-(Q); C-(R)

(C) A-(Q); B-(P); C-(R)

(D) A-(R); B-(P); C-(P)

QUESTION

$V_d = \frac{eE\tau}{m}$ $V_d \propto E$

A

Statement-I: The drift velocity of an electron is doubled if the electric field applied across the conductor is doubled. T

R

Statement-II: The drift velocity of an electron is directly proportional to the electric field applied across the conductor. T

A. Both statement-I and II are correct

B. Both Statement-I and II are incorrect

C. Statement-I is correct and Statement-II is incorrect

D. Statement-I is incorrect and Statement-II is correct

QUESTION

$10^{-4}, 10^{-5}$

Assertion (A): The drift velocity of electrons in a conductor is very small, when its two ends are connected to a battery. T

Reason (R): It is because, as the electrons accelerate, they get deflected on suffering collisions against the positive ions in the conductor. T

A. If Both assertion and reason are true and reason is the correct explanation of the assertion.

B. If Both assertion and reason are true and reason is not correct explanation of the assertion.

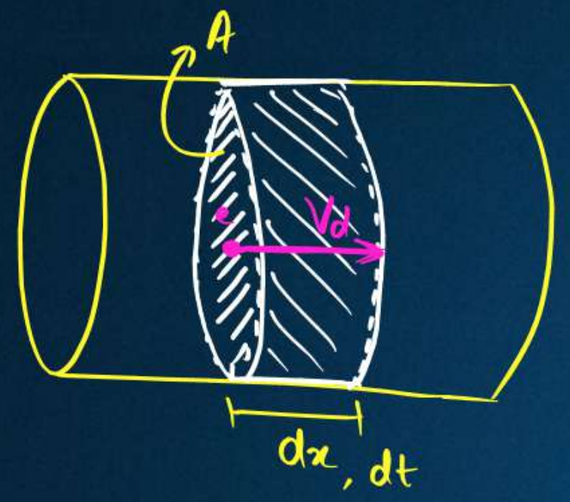
C. If assertion is true, but reason is false.

D. Assertion is false, reason is true

Imp.

Relation b/w Current (i) and Drift speed (V_d)

$$\boxed{i = neAV_d}$$



let the free electron travels 'dx' in small time 'dt'

$$S = \frac{D}{t}$$

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

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

let $n \rightarrow$ number density

$N \rightarrow$ no. of free electrons

$V \rightarrow$ Volume

$A \rightarrow$ Area of Cross-section

$$n = \frac{N}{Vol.}$$

$$n = \frac{N}{A \cdot dx}$$

$$N = nAdx$$

$$i = \frac{dq}{dt}$$

$$i = \frac{Ne}{dt} \quad (q = ne)$$

$$i = \frac{nA\cancel{dx}e}{\frac{\cancel{dx}}{V_d}}$$

$$\boxed{i = neAV_d}$$

- i → Current (A)
- n → no. density (m^{-3})
- e → electronic charge (C)
- A → Area (m^2)
- V_d → drift vel (m/s)

QUESTION

H.W.

Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section 5 mm^2, is v. If the electron density in copper is 9×10^{28} /m^3 the value of v in mm/s is close to (Take charge of electron to be = 1.6×10^{-19} C)

[JEE Main 2019]

A 0.2

B 3

C 2

D 0.02

QUESTION

H.W.

A current of 10 A exists in a wire of cross-sectional area of 5 mm^2 with a drift velocity of 2×10^{-3} ms^{-1}. The number of free electrons in each cubic meter of the wire

[17 March, 2021 (S-I)]

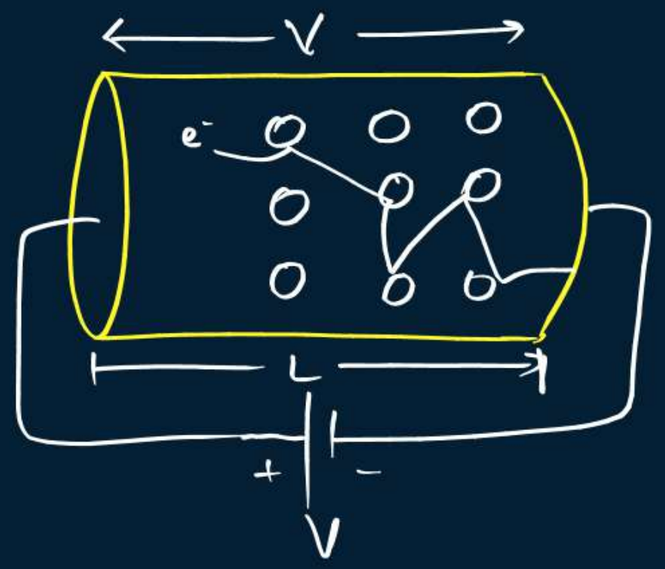
A 2×10^{25}

B 1×10^{23}

C 2×10^{6}

D 625×10^{25}

Resistance and Resistivity (Microscopic Analysis)



$$i = neAV_d \quad \ldots (1)$$

$$V_d = \frac{eE\tau}{m} \quad \ldots (2)$$

put (2) in (1)

$$i = neA\left(\frac{eE\tau}{m}\right)$$

$$i = \frac{ne^2\tau}{m} AE$$

$$i = \frac{ne^2\tau}{m} A\frac{V}{l} \qquad \left(E = \frac{V}{l}\right)$$

$$\frac{i}{V} = \frac{ne^2\tau}{m}\frac{A}{l}$$

$$\frac{V}{i} = \frac{m}{ne^2\tau}\frac{l}{A}$$

$$\boxed{R = \left(\frac{m}{ne^2\tau}\right)\frac{l}{A}} \qquad \left[\frac{V}{i} = R\right]$$

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

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

material, Temperature } depend

SBS :- Temp↑ τ↓ ρ↑

$$\rho \uparrow \propto \frac{1}{\tau \downarrow}$$

QUESTION

The resistivity (specific resistance) of a copper wire [2002]

A. increases with increase in its temperature

B. decreases with increase in its cross-section

C. increases with increase in its length

D. increases with increase in its cross-section

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

Temp ↑ τ ↓ ρ ↑

QUESTION

On increasing the temperature of a conductor, its resistance increases because

A. Relaxation time decreases

B. Mass of the electrons increases

C. Electron density decreases

D. None of the above

Temp ↑ τ ↓ ρ ↑ R ↑

Temperature Dependence Formula

$$R_t = R_0\left(1 + \alpha(\Delta T)\right)$$

$R_t \rightarrow$ Resistance at 't' temp (Ω)

$R_0 \rightarrow$ Resistance at $0^\circ C$ (Ω)

$\Delta T \rightarrow$ Temperature Rise/fall $(t - 0)$ $(^\circ C)$

$\alpha \rightarrow$ Temperature Coefficient of Resistance $(^\circ C^{-1})$

$$R_t = R_0 + R_0 \alpha \Delta T$$

$$R_t - R_0 = R_0 \alpha \Delta T$$

$$\frac{R_t - R_0}{R_0 \Delta T} = \alpha$$

$$\frac{\cancel{\Omega}^{-1}}{\cancel{\Omega}\ ^\circ C} = \alpha$$

$$^\circ C^{-1} = \alpha$$

Hatela Ques

R_0 at $0^\circ C$, R_1 at $t_1^\circ C$, R_2 at $t_2^\circ C$

$\alpha = ?$

$R_1 = R_0(1 + \alpha t_1)$

$R_2 = R_0(1 + \alpha t_2)$

RDx

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

QUESTION

The resistance of a wire at 0°C is 100Ω. If temperature coefficient of resistance is 0.003 /°C. Find resistance of wire at 50 °C.

(A) 110 Ω

(B) 115 Ω

(C) 120 Ω

(D) 125 Ω

$R_0 = 100\,\Omega$

$\alpha = 0.003/^\circ C$

$R_t = ?$

$\Delta T = 50^\circ C$

$R_t = R_0(1 + \alpha(\Delta T))$

$R_t = 100\left(1 + \frac{0.003 \times 50}{100}\right)$

$= 100\left(1 + \frac{15}{100}\right)$

$= 100(1 + 0.15)$

$= 100(1.15)$

$= 115\,\Omega$

QUESTION

Resistance of the wire is measure as 2 Ω and 3 Ω at 10°C and 30°C respectively. Temperature co-efficient of resistance of the material of the wire is:

[28 June, 2022 (Shift-II)]

$\alpha = ?$

(A) $0.033°C^{-1}$

(B) $-0.033°C^{-1}$

(C) $0.011°C^{-1}$

(D) $0.055°C^{-1}$

$R_1 = 2\Omega$ | $t_1 = 10°C$

$R_2 = 3\Omega$ | $t_2 = 30°C$

$\alpha = ?$

RDx

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

$$= \frac{3-2}{2\times30 - 3\times10} = \frac{1}{60-30} = \frac{1}{30}$$

$$= \frac{1}{3}\times\frac{1}{10} = \frac{0.3}{10} = 0.03$$

QUESTION

$\alpha \rightarrow +ve$

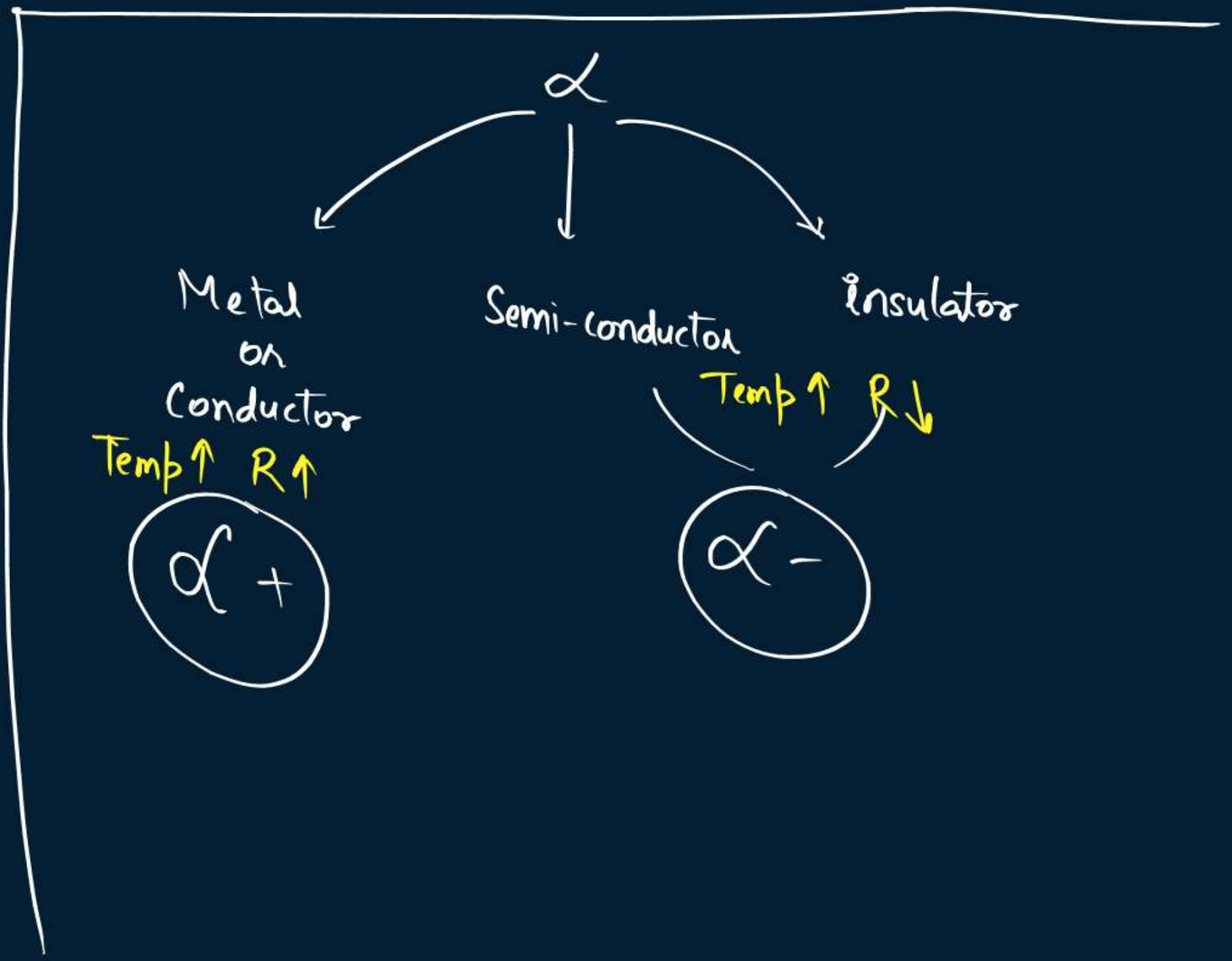
The solids which have the positive temperature coefficient of resistance are

(A) Metals

(B) Insulators only

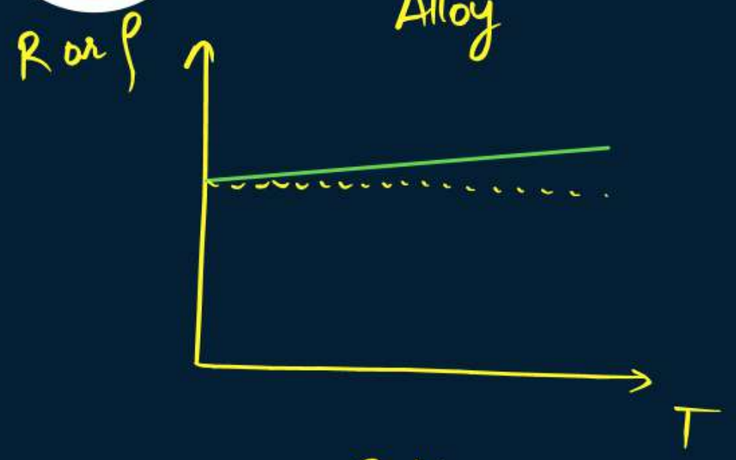
(C) Semiconductors only

(D) Insulators and Semiconductors

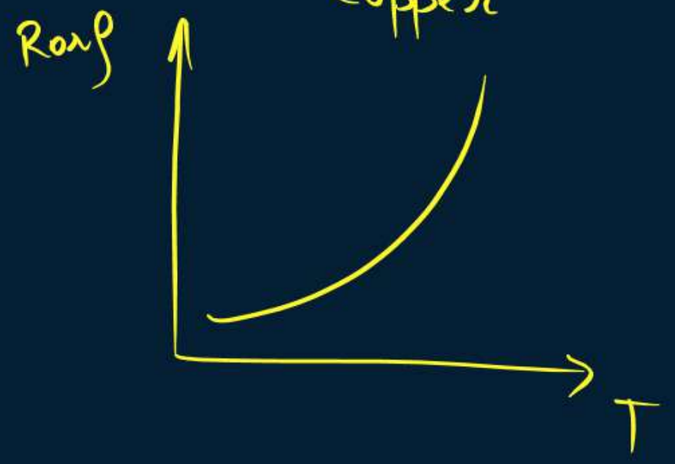


Graphs

Alloy



Copper



Alloys → α → very less

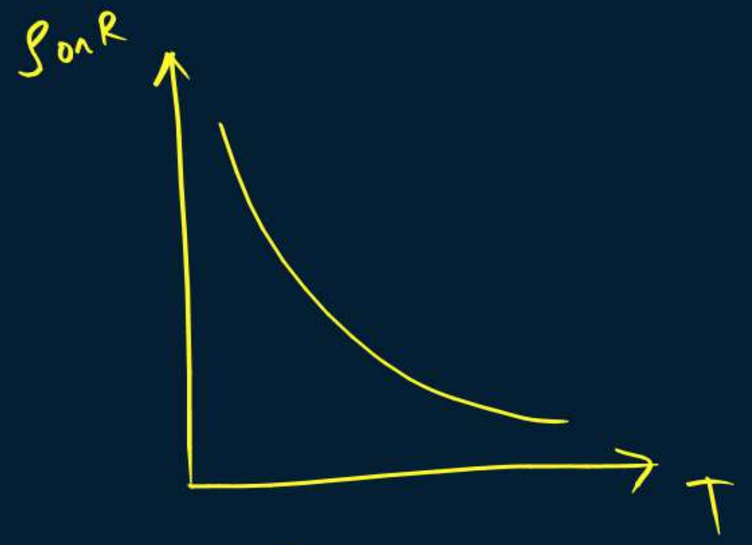
→ T↑ R → constant

उदा

Nichrome- Nickel, Iron, Chromium

Manganin- Cu, Mn, Ni

Constantan- Cu, Ni

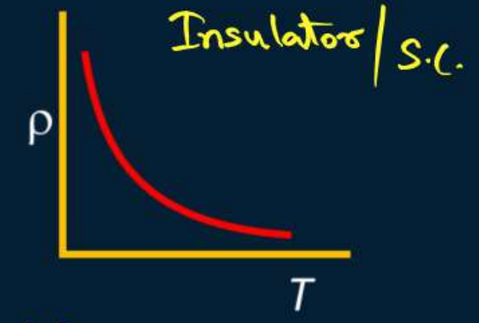


Semiconductor / insulator

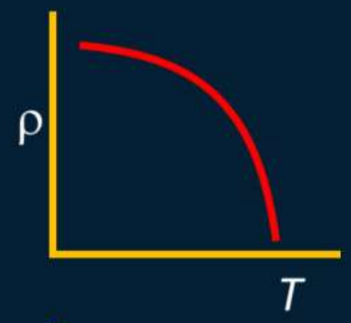
QUESTION

Which of the following graph represents the variation of resistivity (ρ) with temperature (T) for copper ? **[2020]** NEET

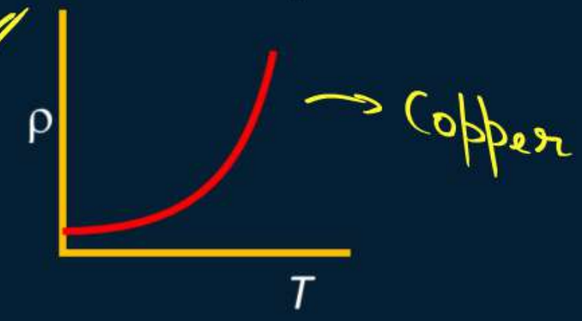
A



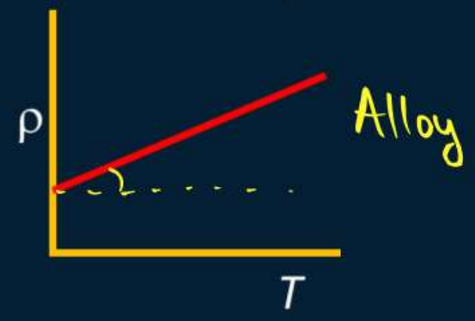
B



C



D



QUESTION

H.W.

Assertion (A): The resistivity of a semiconductor increases with temperature.
Reason (R): Temperature coefficient of resistivity is positive for conductors.

A. If Both assertion and reason are true and reason is the correct explanation of the assertion.

B. If Both assertion and reason are true and reason is not correct explanation of the assertion.

C. If assertion is true, but reason is false.

D. Assertion is false, reason is true

QUESTION

H.W.

Assertion (A): Alloys such as constantan and manganin are used in making standard resistance coils.

Reason (R): Constantan and manganin have very small value of temperature coefficient of resistance.

[29 July, 2022 (Shift-I)]

A. Both (A) and (R) are true and (R) is the correct explanation of A

B. Both (A) and (R) are true but (R) is NOT the correct explanation of A

C. (A) is true but (R) is false

D. (A) is false but (R) is true

Homework

- Notes
- H.W.
- Revision

PARISHRAM

2026

Lecture - 04

Current Electricity

PHYSICS LECTURE - 4

BY - RAKSHAK SIR

Topics *to be covered*

- **A** Current Density, Limitations of Ohm's Law
- **B** Series and Parallel - Electrical Circuits, Wheatstone Bridge
- **C**
- **D**

HW QUESTION

Assertion (A): The drift velocity of electrons in a conductor is very small, when its two ends are connected to a battery. T

Reason (R): It is because, as the electrons accelerate, they get deflected on suffering collisions against the positive ions in the conductor. T

A. If Both assertion and reason are true and reason is the correct explanation of the assertion.

B. If Both assertion and reason are true and reason is not correct explanation of the assertion.

C. If assertion is true, but reason is false.

D. Assertion is false, reason is true

HW QUESTION

Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section 5 mm^2, is v. If the electron density in copper is 9×10^{28} /m^3 the value of v in mm/s is close to (Take charge of electron to be = 1.6×10^{-19} C)

[JEE Main 2019]

(A) 0.2

(B) 3 ✗

(C) 2 ✗

(D) 0.02 ✓

$i = 1.5\ A$

$A = 5 \times 10^{-6}\ m^2$

$n = 9 \times 10^{28}\ /m^3$

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

$V_d = ?$

$i = neAV_d$

$$\frac{i}{neA}$$

$$\frac{\cancel{1.5}\ 1}{9 \times 10^{28} \times \cancel{1.6}_{1} \times 10^{-19} \times 5 \times 10^{-6}} = V$$

$V = \left(\frac{1}{48}\right) mm/s$

$= \frac{1}{50} = 0.02\ mm/s$

HW QUESTION

A current of 10 A exists in a wire of cross-sectional area of 5 mm^2 with a drift velocity of 2×10^{-3} ms^{-1}. The number of free electrons in each cubic meter of the wire

[17 March, 2021 (S-I)]

(A) 2×10^{25}

(B) 1×10^{23}

(C) 2×10^{6}

(D) 625×10^{25}

$i = 10A$

$A = 5\,mm^2 = 5 \times 10^{-6}\,m^2$

$V_d = 2 \times 10^{-3}\,m/s$

$n = ?$

$i = neAV_d$

$10 = n \times 1.6 \times 10^{-19} \times 5 \times 10^{-6} \times 2 \times 10^{-3}$

$\frac{1}{1.6 \times 10^{-19}} = n \times 10^{-9}$

$\frac{6.25 \times 10^{18}}{10^{-9}} = n$

HW QUESTION

$T\uparrow \quad R\uparrow$

On increasing the temperature of a conductor, its resistance increases because

A. Relaxation time decreases

B. Mass of the electrons increases

C. Electron density decreases

D. None of the above

Temp $\uparrow$ no. of collisions $\uparrow$ $\tau\downarrow$ $R\uparrow$

HW QUESTION

Temp↑ ρ↓ → (F)

Assertion (A): The resistivity of a semiconductor increases with temperature.

Reason (R): Temperature coefficient of resistivity is positive for conductors. T

$\alpha \rightarrow +$

A If Both assertion and reason are true and reason is the correct explanation of the assertion.

B If Both assertion and reason are true and reason is not correct explanation of the assertion.

C If assertion is true, but reason is false.

D Assertion is false, reason is true

HW QUESTION

Assertion (A): Alloys such as constantan and manganin are used in making standard resistance coils. T

Reason (R): Constantan and manganin have very small value of temperature coefficient of resistance. [29 July, 2022 (Shift-I)]

α → Very small T
'Alloys'

(A) Both (A) and (R) are true and (R) is the correct explanation of A

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of A

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true

Some Important Terms

1. Mobility (μ) = $\frac{\text{drift speed } (V_d)}{\text{Electric field } (E)}$

→ Mu

(# electrons ki chaal)

$$\boxed{\mu = \frac{V_d}{E}} \quad \text{---} (1)$$

put, $V_d = \frac{eE\tau}{m}$ in (1)

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

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

or $\mu \propto \tau$, $\propto \frac{1}{m}$

* SI unit of μ

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

$$= \frac{m}{s} \cdot \frac{V}{m}$$

$$\mu = \frac{m^2}{V\text{-}s} \text{ or } \boxed{\frac{cm^2}{V\text{-}s}}$$

Practical Unit

2. Conductance is reciprocal of Resistance

$$\boxed{G = \frac{1}{R}} \text{ or } G = \frac{A}{\rho l}$$

mho or Seimens ← G; R → ohm

$$\boxed{G = \frac{\sigma A}{l}}$$

3. Conductivity is the reciprocal of resistivity

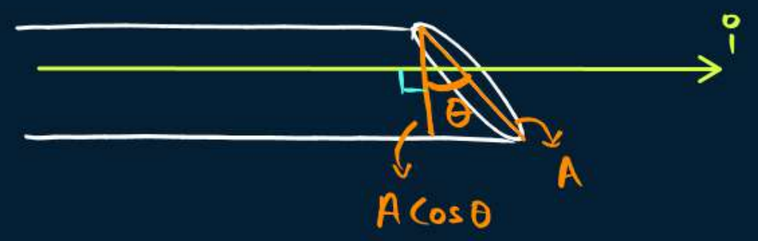
$$\boxed{\sigma = \frac{1}{\rho}} \text{ or } \frac{1}{\frac{m}{ne^2\tau}} = \frac{ne^2\tau}{m}$$

mho-m^{-1} or Seimens-m^{-1} ← σ; ρ → ohm-m

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

Current Density ($\vec{J}$) : direction is same as current

It is defined as current flowing per unit cross-sectional Area perpendicularly.



$$\text{Current density} = \frac{\text{Current}}{\perp \text{Area}}$$

$$J = \frac{i}{A\cos\theta}$$

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

$i \rightarrow$ Ampere

$A \rightarrow (\text{metre})^2$

$J \rightarrow \frac{A}{m^2}$ or $A\text{-}m^{-2}$

$$\boxed{\begin{aligned} JA\cos\theta &= i \\ \vec{J}\cdot\vec{A} &= i \end{aligned}}$$

$\vec{J} \rightarrow$ Vector

$i \rightarrow$ Scalar

* Microscopic Form of Ohm's Law

$V = IR$: Macroscopic form of ohm's Law.

$$E\cancel{l} = J\cancel{A}\left(\rho\frac{\cancel{l}}{\cancel{A}}\right)$$

$$\left[\begin{array}{l} V = E \times l \\ I = J \cdot A \\ R = \rho\frac{l}{A} \end{array}\right]$$

$$E = J\rho$$

$$\frac{E}{\rho} = J$$

$$\left[\frac{1}{\rho} = \sigma\right]$$

$$\sigma E = J$$

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

Vector form of Ohm's Law

QUESTION

The electric field E, current density J and conductivity σ of a conductor are related as

(A) σ = E/j

(B) σ = j/E

(C) σ = jE

(D) σ = 1/Ej

$J = \sigma E$

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

$\sigma E = J$

QUESTION BAWAAL QUES → 10 Ques – 4 Ques.

Across a metallic conductor of non-uniform cross-section a constant potential difference is applied. The quantity which remains constant along the conductor is

$V \propto i$

4) Current Density [2015]

$J = \frac{i}{A}$ → constant

$J \downarrow \propto \frac{1}{A} \uparrow$

$A_2 > A_1$

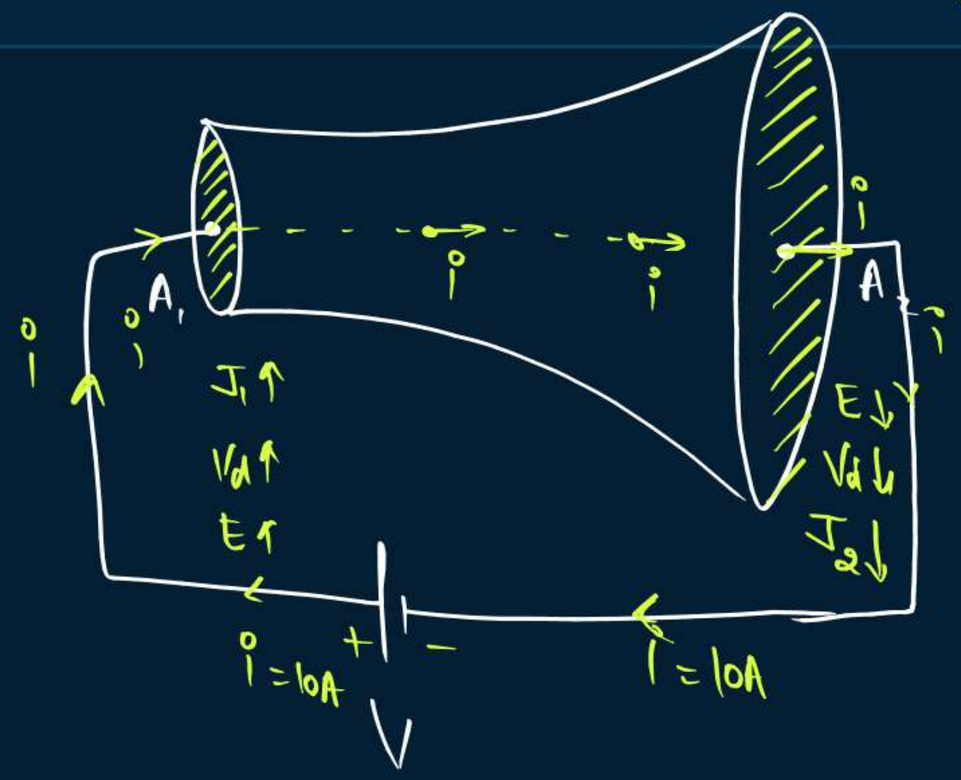
$J_2 < J_1$

(A) Current (i)

(B) drift velocity (V_d)

(C) electric field (E)

(D) current density (J)



Drift Velocity

$i = neAV_d$

$\frac{i}{A} = neV_d$

$J = neV_d$

$J \propto V_d$

$A_1 < A_2$

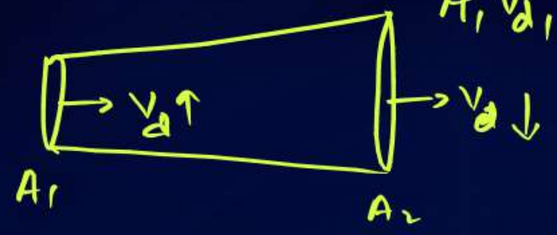
$J_1 > J_2$

$V_{d_1} > V_{d_2}$

fluids

$A_1V_1 = A_2V_2$ → eq. of continuity

$A_1V_{d_1} = A_2V_{d_2}$



Electric field

$J = \sigma E$

$J \propto E$

$A_1 < A_2$

$J_1 > J_2$

$V_{d_1} > V_{d_2}$

$E_1 > E_2$

QUESTION

H.W.

Column I- Gives certain physical terms associated with flow of current through a metallic conductor.

Column II- Gives some mathematical relations involving electrical quantities. Match column I and column II with appropriate relation. **[NEET 2021]**

	Column I		Column II
A.	Drift velocity	1.	$\frac{m}{ne^2\rho}$
B.	Electrical resistivity	2.	nev_d
C.	Relaxation period	3.	$\frac{eE}{m}\tau$
D.	Current density	4.	$\frac{E}{J}$

	A	B	C	D
A	3	4	1	2
B	3	4	2	1
C	3	1	4	2
D	3	2	4	1

QUESTION

H.W.

Match the Column-I with Column-II.

Column-I		Column-II	
A.	SI unit of mobility of a charge carrier	P.	mho-m^{-1}
B.	SI unit conductivity	Q.	Am^{-2}
C.	SI unit of current density	R.	$m^2V^{-1}s^{-1}$

A. A-(R); B-(P); C-(Q)

B. A-(P); B-(Q); C-(R)

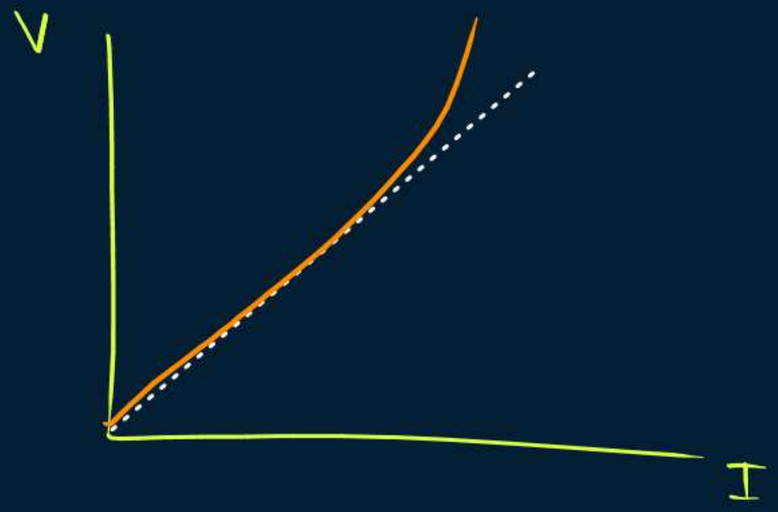
C. A-(Q); B-(P); C-(R)

D. A-(R); B-(Q); C-(P)

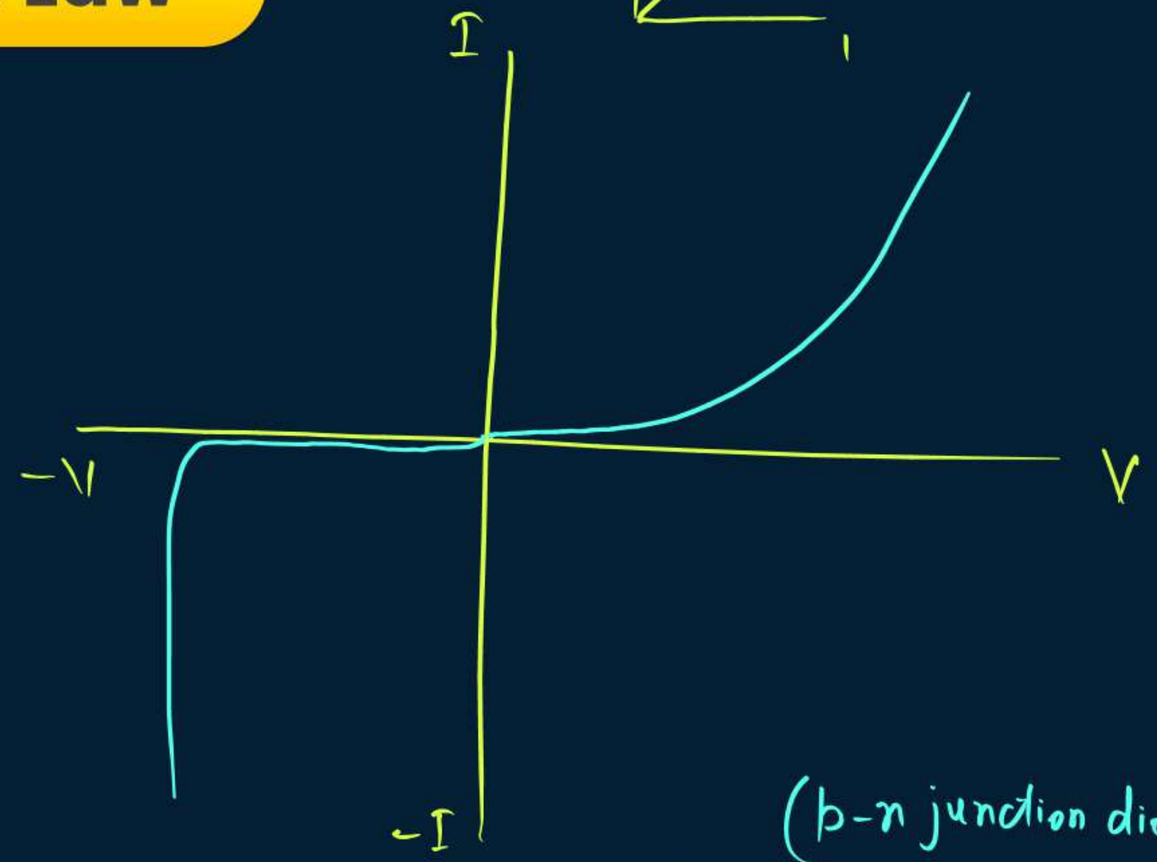
Limitations of Ohm's Law

$V \propto I$

↳ linear graph



Non-ohmic conductors

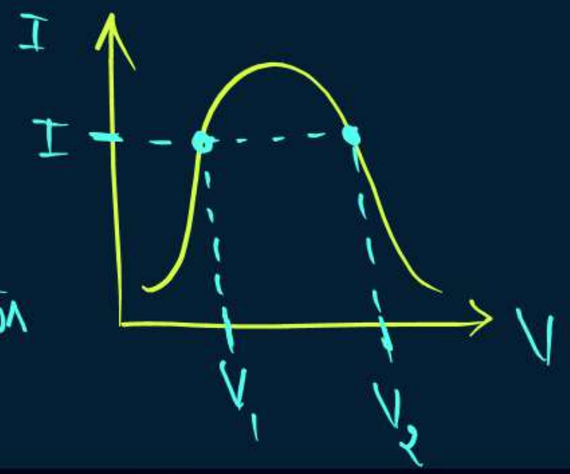


(p-n junction diode)

Semiconductor diode

'Graft'

Semiconductor diode



QUESTION

Hw.

Statement-I: Ohm's law is applicable to all conductors of electricity including diodes.
Statement-II: In an electrolytic solution, the electric current is mainly due to the movement of free electrons.

A. Both statement-I and II are correct

B. Both Statement-I and II are incorrect

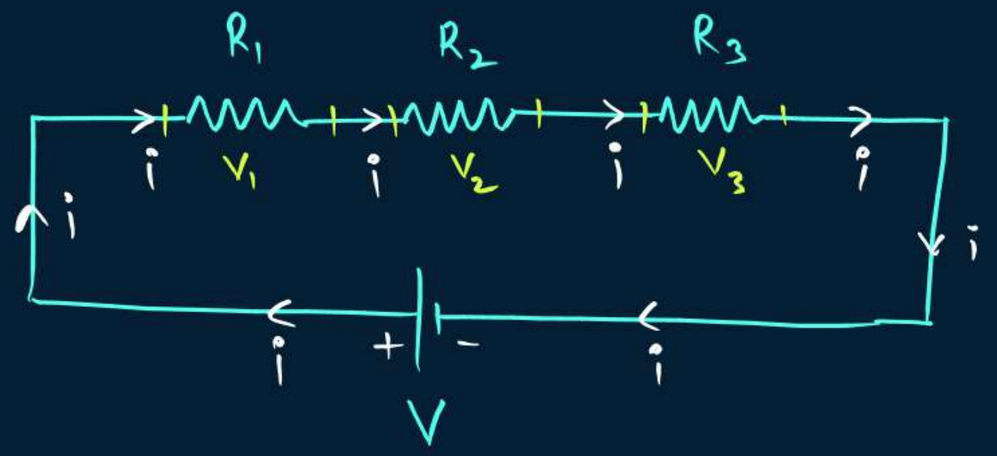
C. Statement-I is correct and Statement-II is incorrect

D. Statement-I is incorrect and Statement-II is correct

Electrical Circuits – a) Series Combination

Potential divider

Current same



$$V = V_1 + V_2 + V_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad (V = IR)$$

$$\cancel{I}R_T = \cancel{I}(R_1 + R_2 + R_3)$$

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

$i \rightarrow$ Same

$$V = iR$$

$$V \propto R$$

$$\boxed{\frac{V_1}{V_2} = \frac{R_1}{R_2}}$$

Spl. case :-

n – identical resistors..

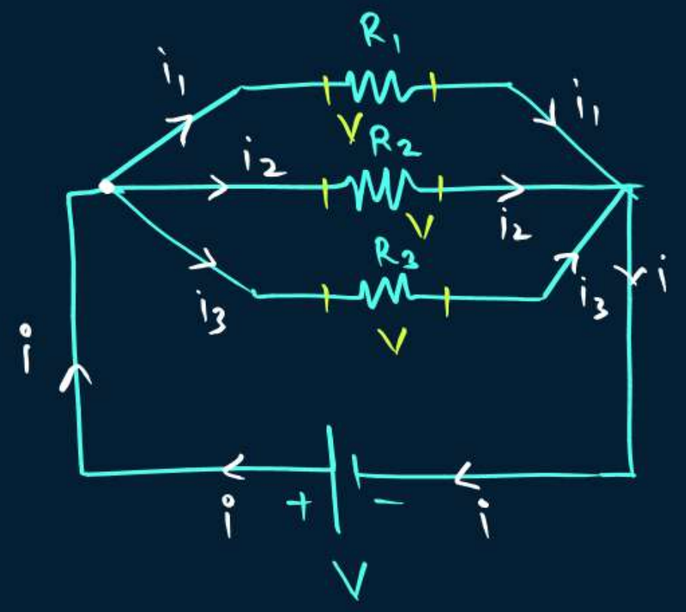
$$R_s = R + R + R + R + \ldots n$$

$$\boxed{R_s = nR}$$

b) Parallel Combination

i divide

V same



$$i = i_1 + i_2 + i_3$$

$$\left(\begin{array}{l} V = iR \\ i = \frac{V}{R} \end{array}\right)$$

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

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

$$V = iR$$

Const.

Const. $= iR$

$$i \downarrow \propto \frac{1}{R \uparrow}$$

$$\boxed{i_1 R_1 = i_2 R_2}$$

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

$$\frac{R_s}{R_p} = \frac{n\cancel{R}}{\frac{\cancel{R}}{n}} = n^2$$

$$\boxed{\frac{R_s}{R_p} = n^2} \qquad \boxed{\frac{C_s}{C_p} = \frac{1}{n^2}}$$

Spl. case

n- identical resistors

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \cdots n$$

$$\frac{1}{R_p} = \frac{n}{R}$$

$$\boxed{R_p = \frac{R}{n}}$$

Spl. Case : only 2 resistors

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

QUESTION

Statement-I: The equivalent resistance of resistors in a series combination is smaller than least resistance used in the combination. F

Statement-II: The resistivity of the material is independent of temperature. F

[15 April, 2023 (S-I)]

NOTE- Series ka Total, Bade Wale se Bhi Bada hoga
Parallel ka Answer, Chote Wale se Bhi Chota hoga

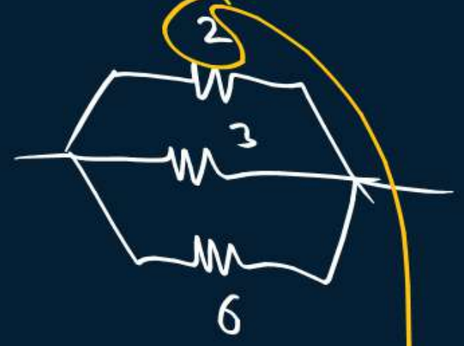
(A) Statement-I is false but Statement-II is true

(B) Both Statement-I and Statement-II are false

(C) Statement-I is true but Statement-II is false

(D) Both Statement-I and Statement-II are true

$= R_s = 13\,\Omega$



$$\frac{1}{R_p} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_p} = \frac{3+2+1}{6} = \frac{6}{6} = 1$$

$$R_p = 1\,\Omega$$

QUESTION

H.W.

The effective resistance of a parallel connection that consists of four wires of equal length, equal area of cross-section and same material is 0.25Ω. What will be the effective resistance if they are connected in series? [NEET 2021]

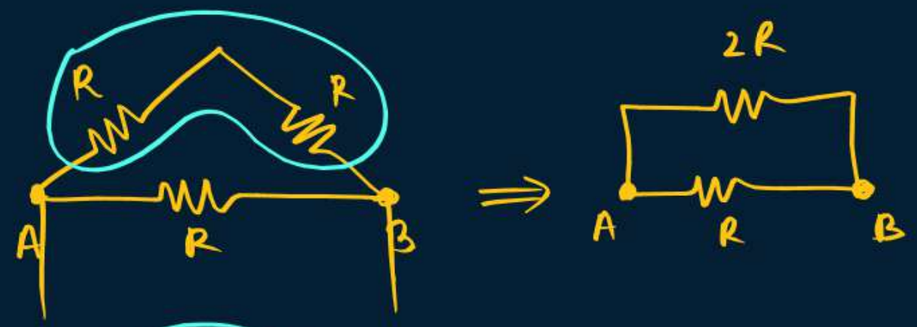
(A) 0.25 Ω

(B) 0.5 Ω

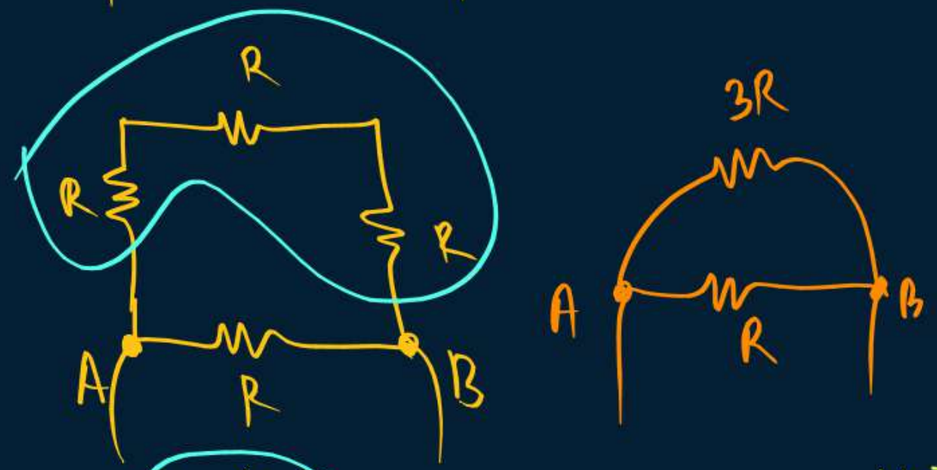
(C) 1 Ω

(D) 4 Ω

RDx Patterns



$$\frac{2R^2}{2R+R} = \frac{2R^{\cancel{2}}}{3\cancel{R}} = \frac{2R}{3}$$



$$\frac{3R^2}{3R+R} = \frac{3R^{\cancel{2}}}{4\cancel{R}} = \frac{3R}{4}$$

$$\frac{4R^2}{4R+R} = \frac{4R^{\cancel{2}}}{5\cancel{R}} = \frac{4R}{5}$$

QUESTION

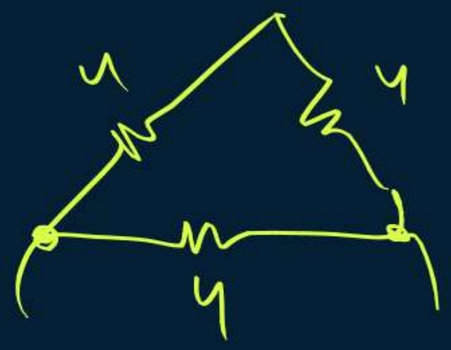
Three resistances each of 4 are connected to form a triangle. The resistance between any two terminals is [1993]

(A) 12 Ω

(B) 2 Ω

(C) 6 Ω

(D) 8/3 Ω



$$\frac{2R}{3} = \frac{2 \times 4}{3} = \frac{8}{3}\,\Omega$$

QUESTION

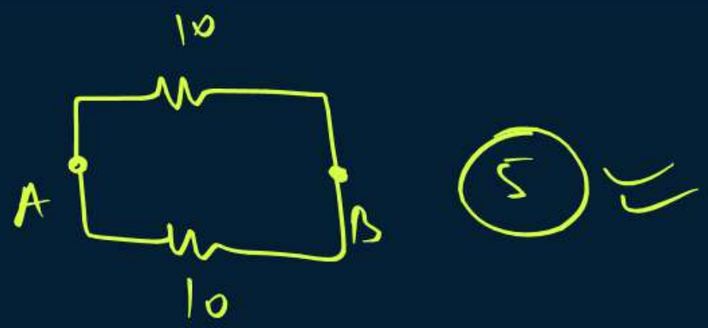
A wire of resistance 20 ohms is bent to form a complete circle of radius 10 cm. The resistance between its two diametrically opposite points, A and B as shown in the figure, is

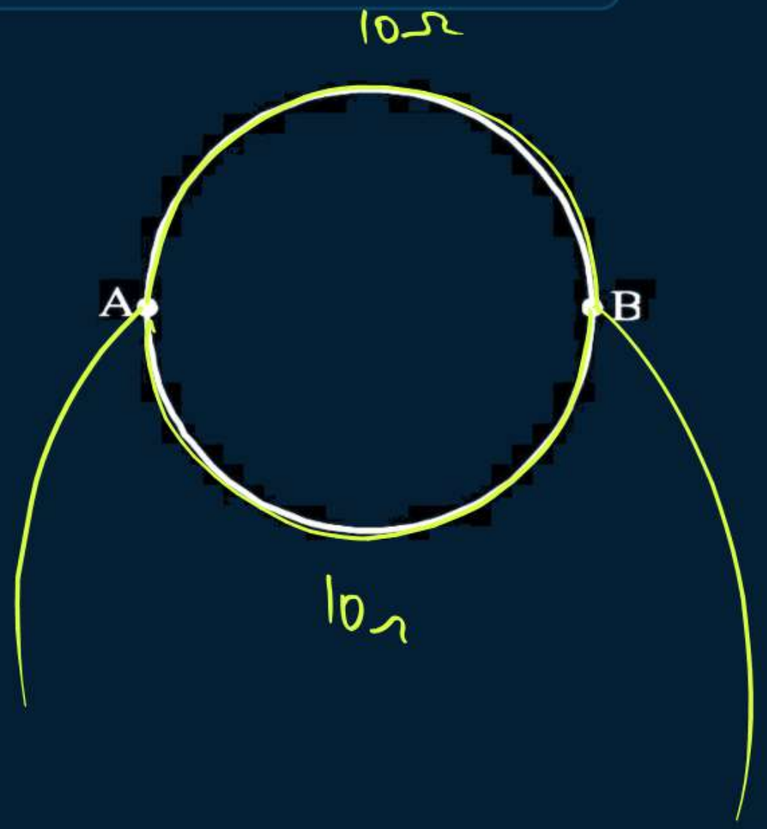
(A) 10 Ω

(B) 5 Ω

(C) 15 Ω

(D) 20 Ω





QUESTION

H.W.

A wire of 16 Ω is bent in the form of a circle as shown. Find R_{eq} between A & B?

QUESTION

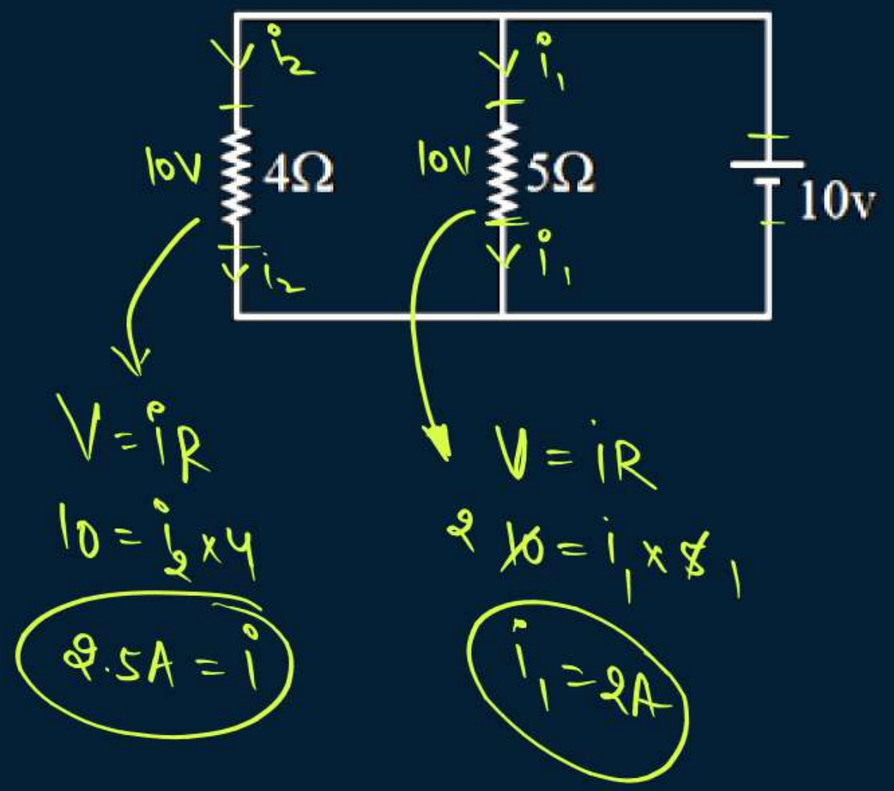
In the following diagram current in the 5 Ω resistor is (when the internal resistance of the battery is zero):

(A) 4.5 A

(B) 2 A

(C) 2.5 A

(D) Zero



QUESTION

Current through 3Ω resistor is 0.8 amp., then potential drop through 4 Ω resistor is [1993]

(A) 9.6 V

(B) 2.6 V

(C) 4.8 V

(D) 1.2 V

V is same at 3Ω and 6Ω

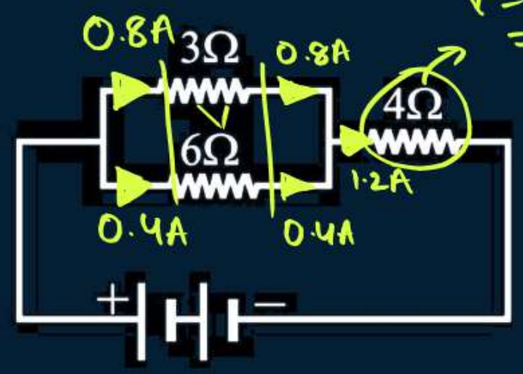
$V_{3\Omega} = V_{6\Omega}$

$i_1 R_1 = i_2 R_2$

$0.8 \times 3 = i_2 \times 6$

$\frac{0.8 \times 3}{6} = i_2$ (0.4)

$i_2 = 0.4A$

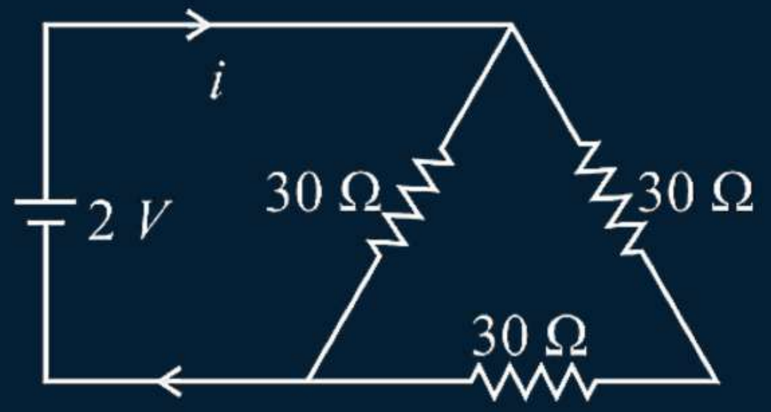


$V = iR$
$= 1.2 \times 4$
$= 4.8V$

QUESTION

H.W.

The current in the adjoining circuit will be



(A) $\frac{1}{45}$ ampere

(B) $\frac{1}{15}$ ampere

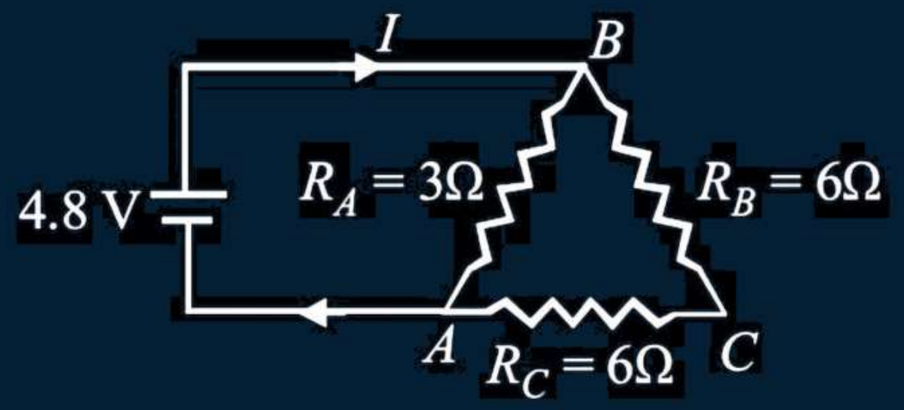
(C) $\frac{1}{10}$ ampere

(D) $\frac{1}{5}$ ampere

QUESTION

H.W.

The current (I) in the given circuit is [1999]



(A) 1.6 A

(B) 2.0 A

(C) 0.32 A

(D) 3.2 A

QUESTION

$\frac{18\times6}{18+6} = \frac{18\times6}{24} = 4.5$

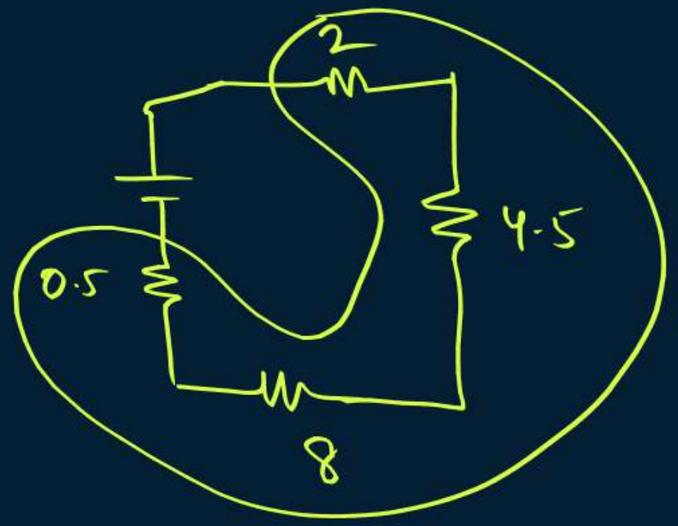
The current from the battery in circuit diagram shown is

(A) 1 A

(B) 2 A

(C) 1.5 A

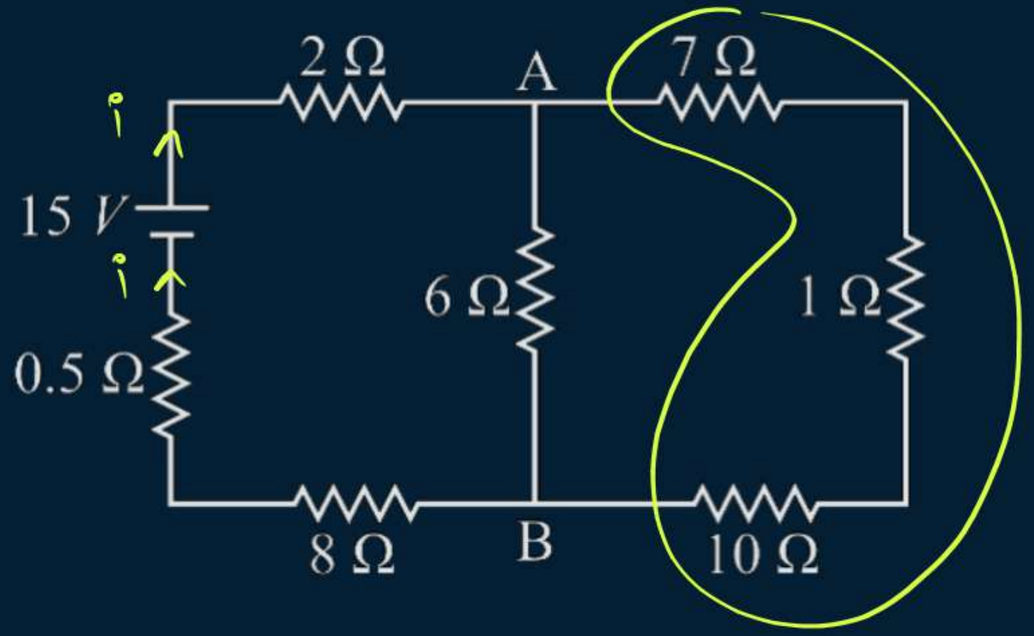
(D) 3 A



$R = 15\Omega$

$V = 15V$

$i = 1A$



QUESTION

The equivalent resistance between A and B as shown in figure is:

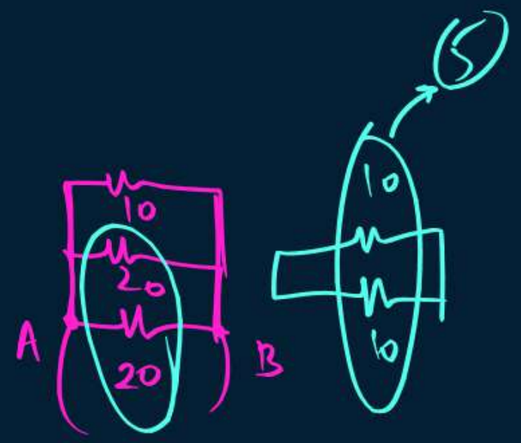
[08 April, 2023 (S-II)]

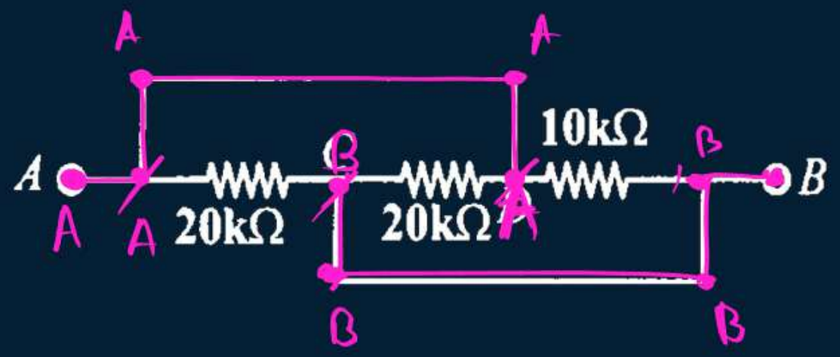
(A) 5 kΩ

(B) 30 kΩ

(C) 10 kΩ

(D) 20 kΩ

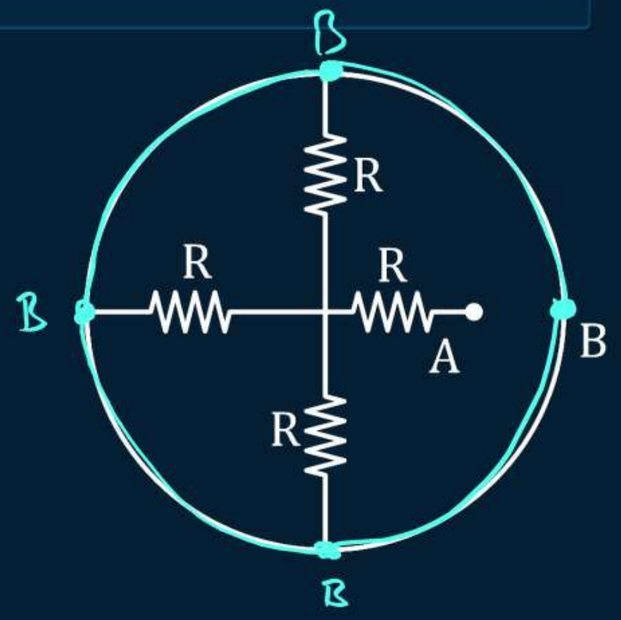




QUESTION

H.W.

Req between A and B?



A. R/4

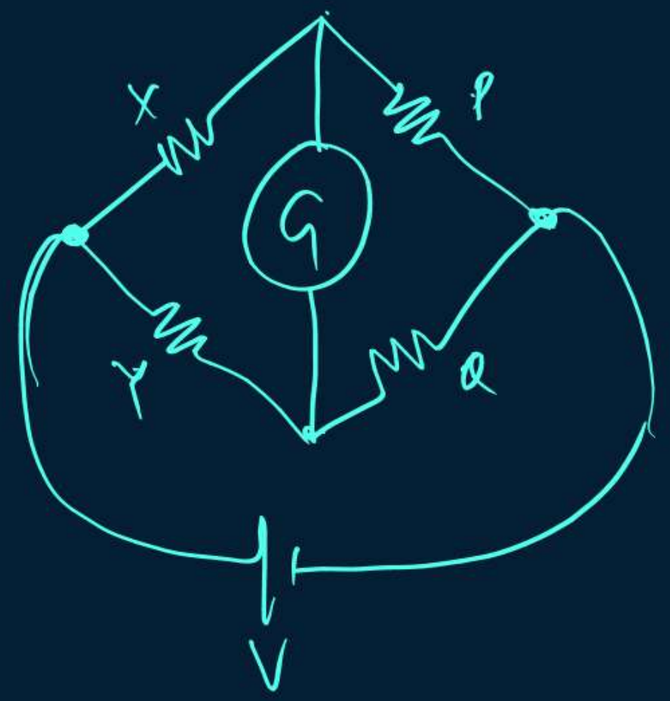
B. 4R/3

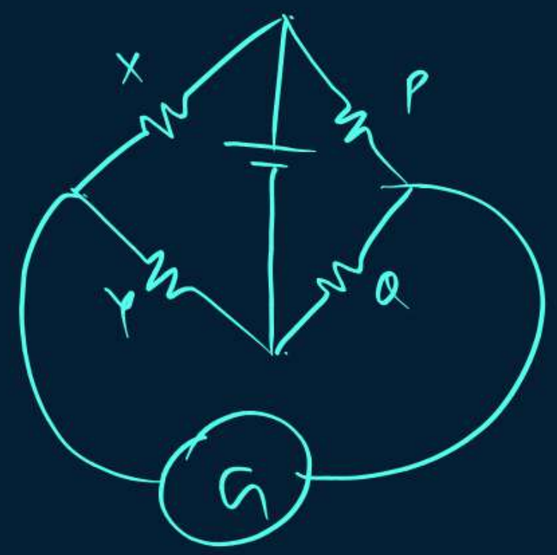
C. 3R/4

D. None

Wheat-Stone Bridge

Balanced W.S.B. $\Rightarrow \frac{X}{Y} = \frac{P}{Q}$, ignore M

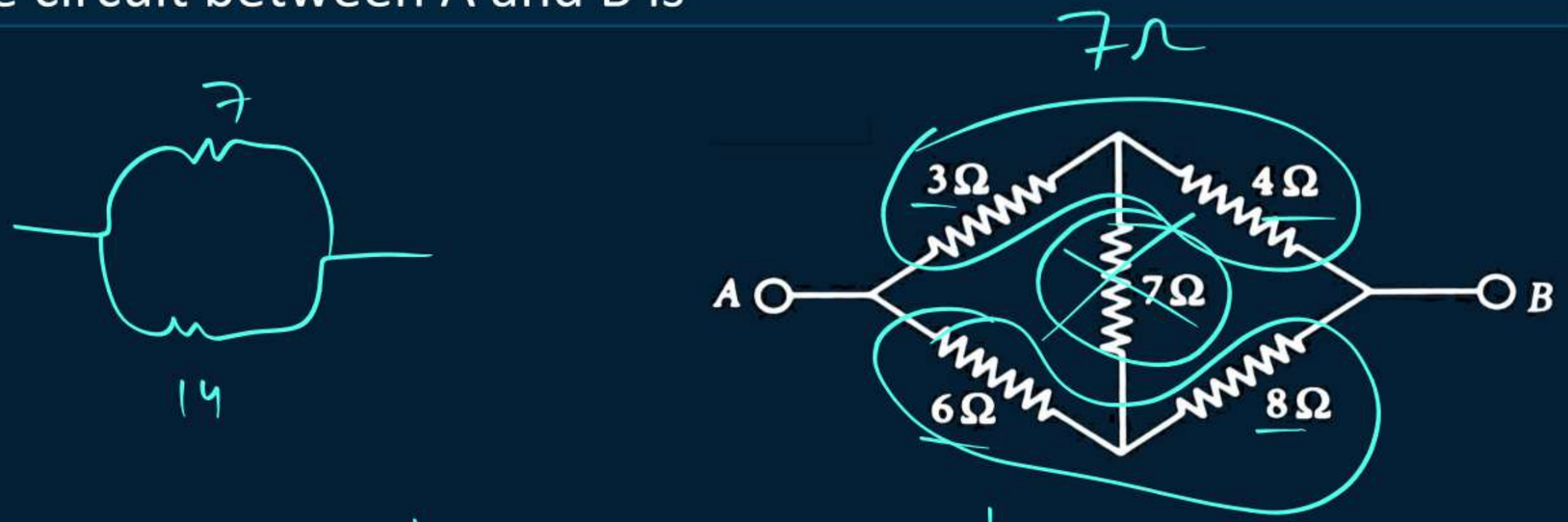




If Galvanometer and Battery are interchanged, bridge still remains balanced.
(no deflection in galvanometer)

QUESTION

The net resistance of the circuit between A and B is



(A) 8/3 Ω

(B) 14/3 Ω

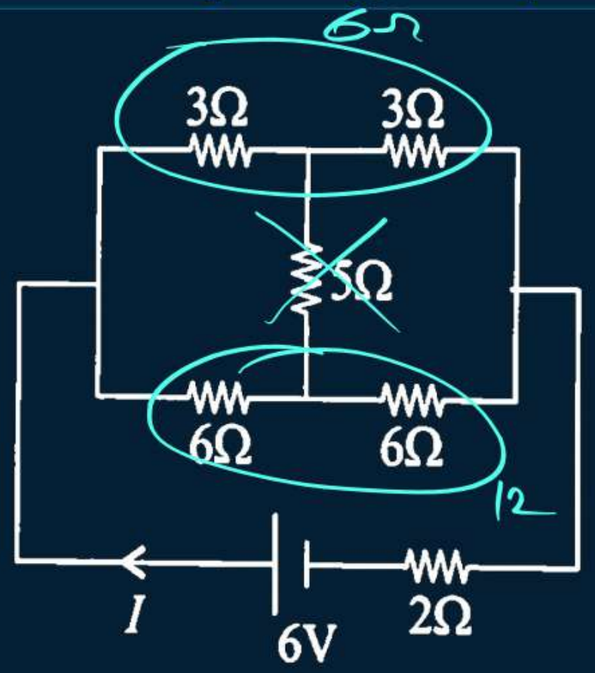
(C) 16/3 Ω

(D) 22/3 Ω

QUESTION

A battery of 6V is connected to the circuit as shown below. The current I drawn from the battery is:

[26 July, 2022 (S-II)]



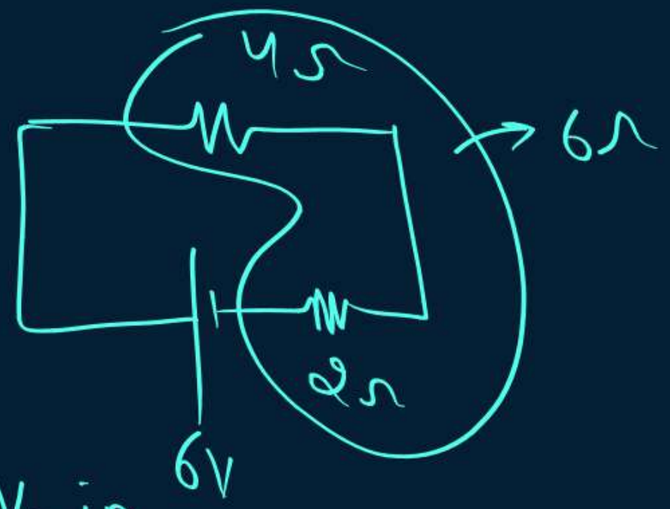
(A) 8/3 Ω

(B) 14/3 Ω

(C) 16/3 Ω

(D) 22/3 Ω

$\frac{6\times12}{18} = 4\Omega$



$V = iR$

$6 = i\,6$

$i = 1A$

QUESTION

H.W.

Four resistances of 15 Ω, 12 Ω, 4 Ω and 10 Ω respectively in cyclic order to form Wheatstone's network. The resistance that is to be connected in parallel with the resistance of 10 Ω to balance the network is _____ . [JEE Mains]

(A) 5 Ω

(B) 10 Ω

(C) 15 Ω

(D) 12 Ω

Homework

- Notes
- In-class H.W.
- Revision

PARISHRAM

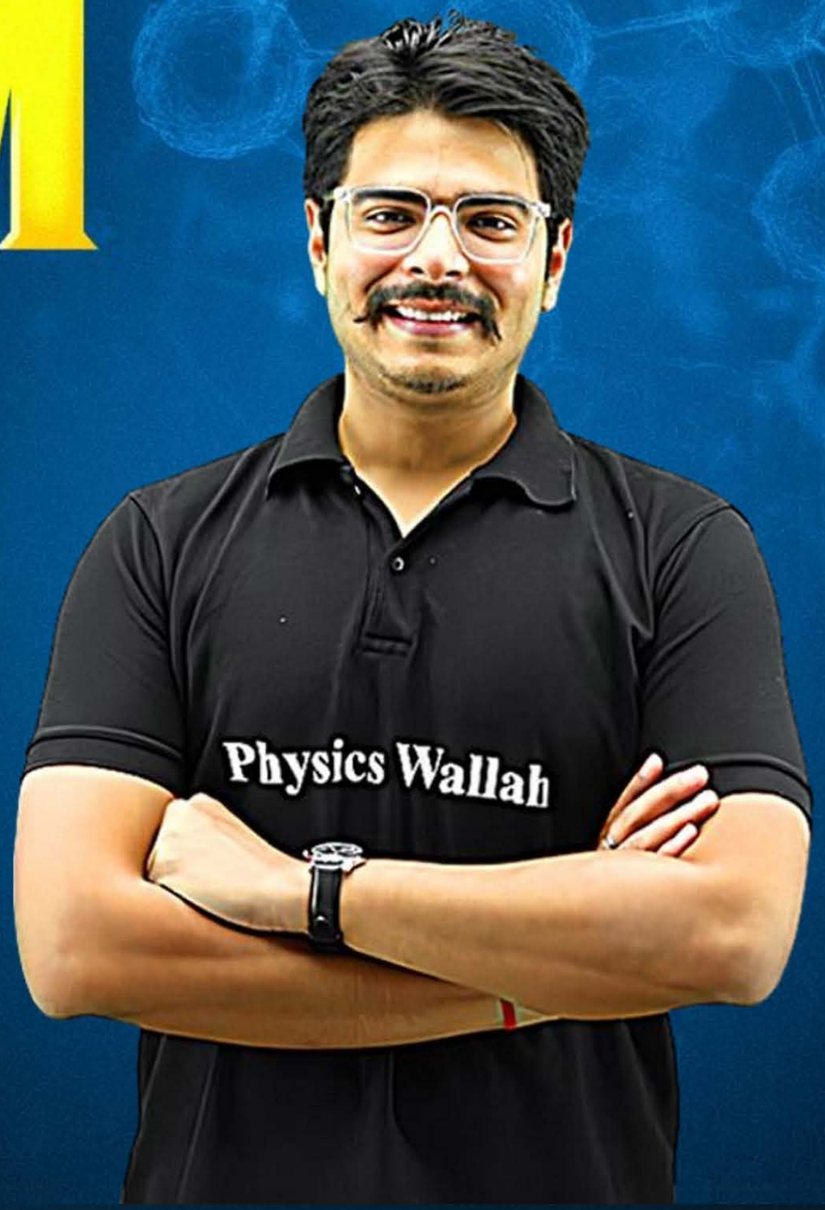
2026

Lecture-05

Current Electricity

PHYSICS **Lecture : 05**

BY - RAKSHAK SIR



Topics *to be covered*

A

B

C Kirchoff's Laws ✓

D

QUESTION H.W

$J = \sigma E$

$J = \frac{E}{\rho} \rightarrow \rho = \frac{E}{J}$

Column I- Gives certain physical terms associated with flow of current through a metallic conductor.

Column II- Gives some mathematical relations involving electrical quantities. Match column I and column II with appropriate relation. **[NEET 2021]**

	Column I		Column II
A.	Drift velocity	1.	$\frac{m}{ne^2\rho}$
B.	Electrical resistivity	2.	nev_d
C.	Relaxation period	3.	$\frac{eE}{m}\tau$
D.	Current density	4.	$\frac{E}{J}$

$V_d = \frac{eE\tau}{m}$

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

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

	A	B	C	D
A	3	4	1	2
B	3	4	2	1
C	3	1	4	2
D	3	2	4	1

QUESTION

HW

Match the Column-I with Column-II.

	Column-I		Column-II
A.	SI unit of mobility of a charge carrier (μ)	P.	mho-m^{-1}
B.	SI unit conductivity (σ)	Q.	Am^{-2}
C.	SI unit of current density (J)	R.	$m^2V^{-1}s^{-1}$

(A) A-(R); B-(P); C-(Q)

(B) A-(P); B-(Q); C-(R)

(C) A-(Q); B-(P); C-(R)

(D) A-(R); B-(Q); C-(P)

QUESTION

HW

F S.C.

Statement-I: Ohm's law is applicable to all conductors of electricity including diodes.

Statement-II: In an electrolytic solution, the electric current is mainly due to the movement of free electrons. F

Ions

(A) Both statement-I and II are correct

(B) Both Statement-I and II are incorrect

(C) Statement-I is correct and Statement-II is incorrect

(D) Statement-I is incorrect and Statement-II is correct

QUESTION

HW

$R_p = 0.25\Omega$

The effective resistance of a parallel connection that consists of four wires of equal length, equal area of cross-section and same material is 0.25Ω. What will be the effective resistance if they are connected in series? [NEET 2021]

(A) 0.25 Ω

(B) 0.5 Ω

(C) 1 Ω

(D) 4 Ω

$\frac{R_s}{R_p} = n^2$

$R_s = n^2 R_p$

$= (4)^2 \times \frac{1}{4}$

$= 4$

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

$\frac{1}{0.25} = \frac{4}{R}$

$R = 0.25 \times 4 = 1\Omega$

$R = 1\Omega$

$R_s = R + R + R + R$

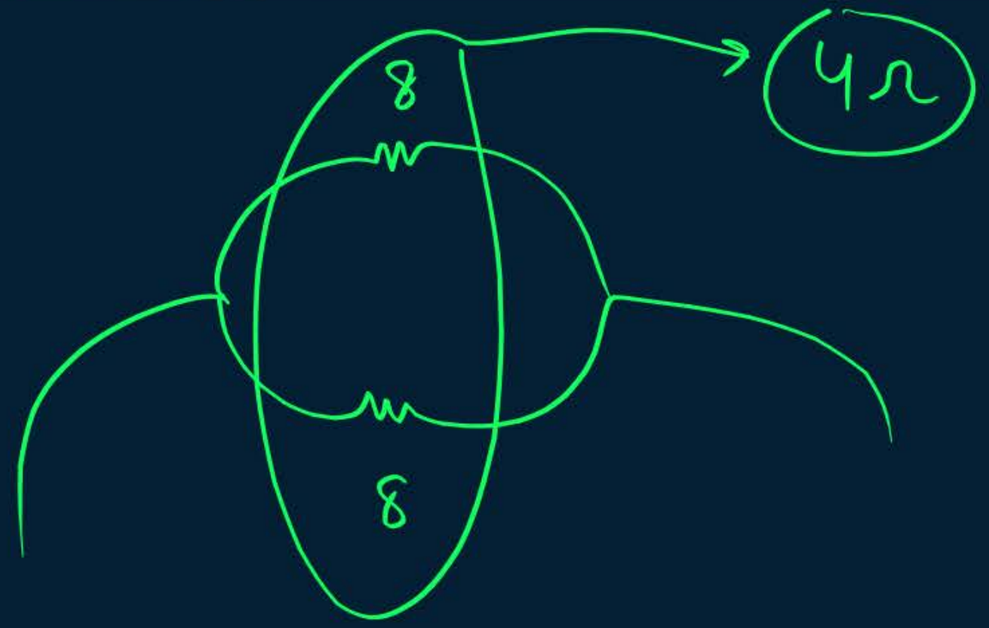
$R_s = 1 + 1 + 1 + 1$

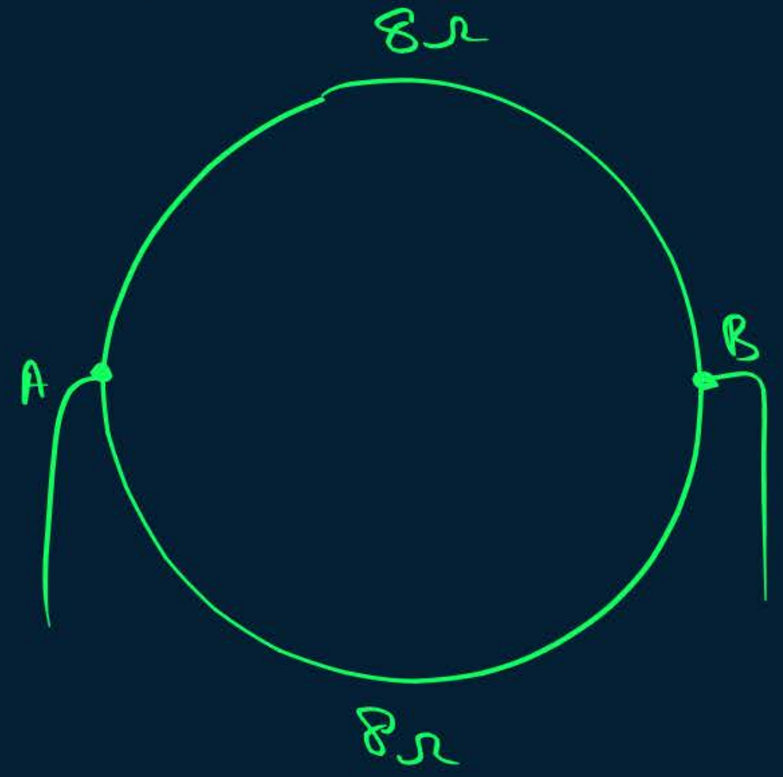
$R_s = 4\Omega$

QUESTION

HW

A wire of 16 Ω is bent in the form of a circle as shown. Find R_{eq} between A & B?

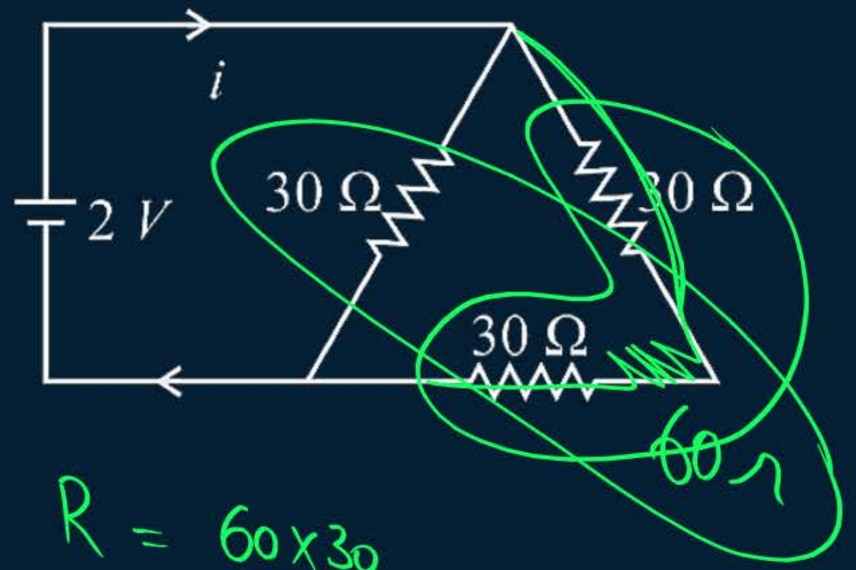




QUESTION

HW

The current in the adjoining circuit will be



(A) $\frac{1}{45}$ ampere

(B) $\frac{1}{15}$ ampere

(C) $\frac{1}{10}$ ampere

(D) $\frac{1}{5}$ ampere

$V = iR$

$2 = i \times 20$

$i = \frac{\cancel{2}\,1}{\cancel{20}\,10}$

$i = 0.1\,A$

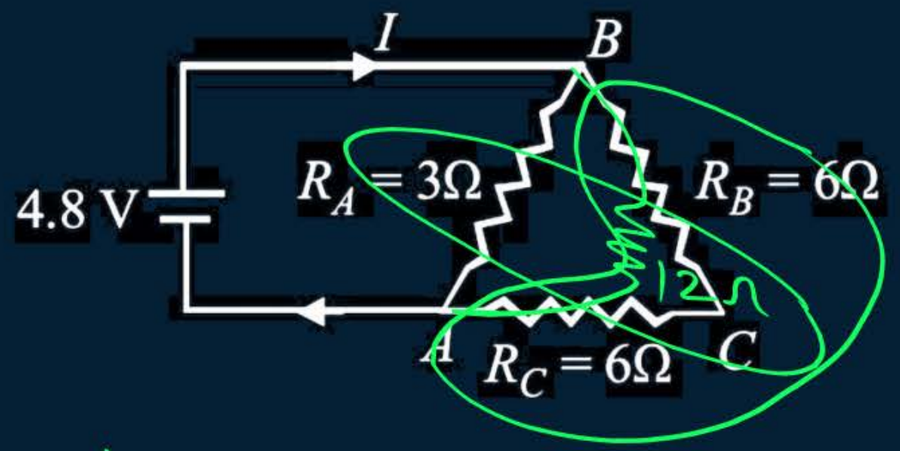
$R = \frac{60 \times 30}{60 + 30}$

$= \frac{\cancel{60}^{20} \times \cancel{30}^{1}}{\cancel{90}_{\cancel{3}}} = 20\,\Omega$

QUESTION

HW

The current (I) in the given circuit is [1999]



(A) 1.6 A

(B) 2.0 A

(C) 0.32 A

(D) 3.2 A

$V = iR$

$\frac{48}{10} = i \times \frac{12}{5}$

$i = 2A$

$\frac{12 \times 3}{12+3} = \frac{36}{15} = \frac{12}{5}\Omega$

QUESTION

HW

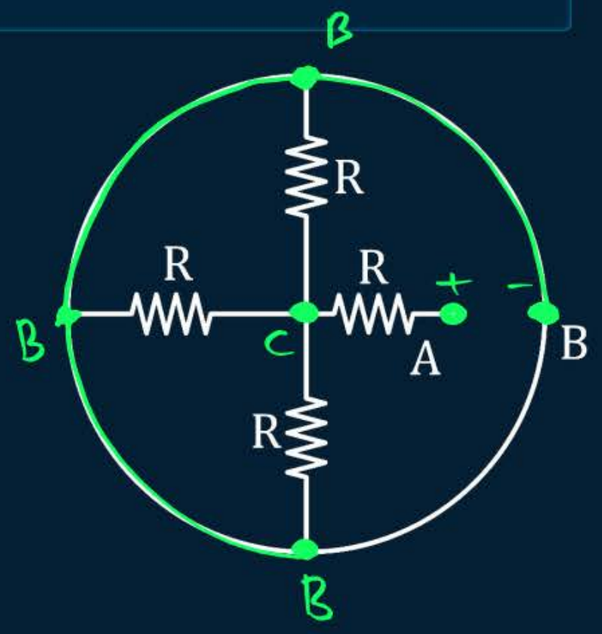
Req between A and B?

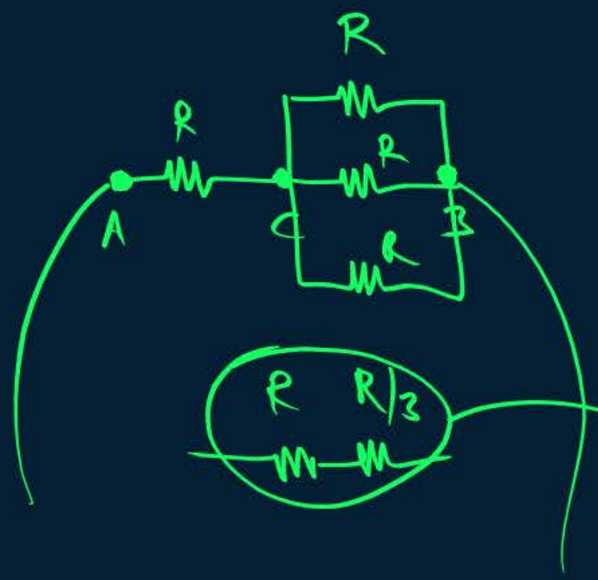
A. R/4

B. 4R/3

C. 3R/4

D. None





$R + \frac{R}{3} = \frac{4R}{3}$

QUESTION

HW

B.P.U

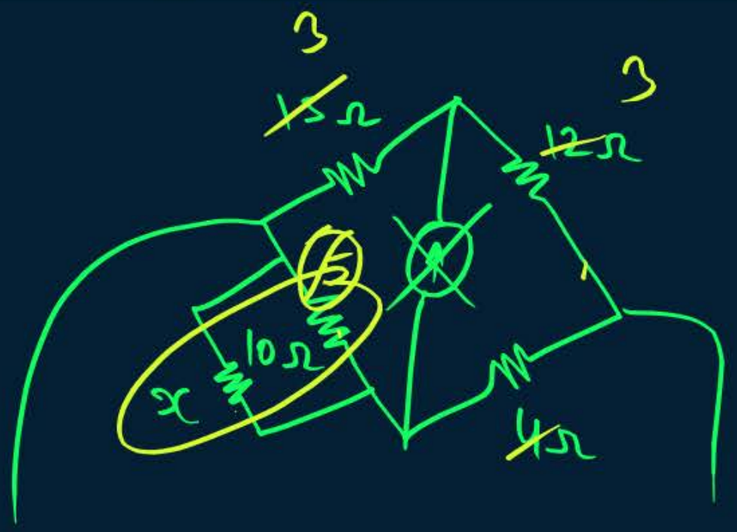
Four resistances of 15 Ω, 12 Ω, 4 Ω and 10 Ω respectively in cyclic order to form Whetstone's network. The resistance that is to be connected in parallel with the resistance of 10 Ω to balance the network is __10Ω__ . [JEE Mains]

(A) 5 Ω

(B) 10 Ω

(C) 15 Ω

(D) 12 Ω



$\frac{10x}{10+x}$

W.S.B. Balanced condⁿ

$$\frac{\frac{5\,15}{10x}}{10+x} = \frac{12\,3}{4\,1}$$

$$\frac{5}{\frac{10x}{10+x}} = \frac{1}{1}$$

$$5 = \frac{10x}{10+x} \rightarrow 50 + 5x = 10x$$

$$\frac{50}{10} = 5x$$

$x = 10\Omega$

Kirchoff's Laws – 1. Junction (Current) Law

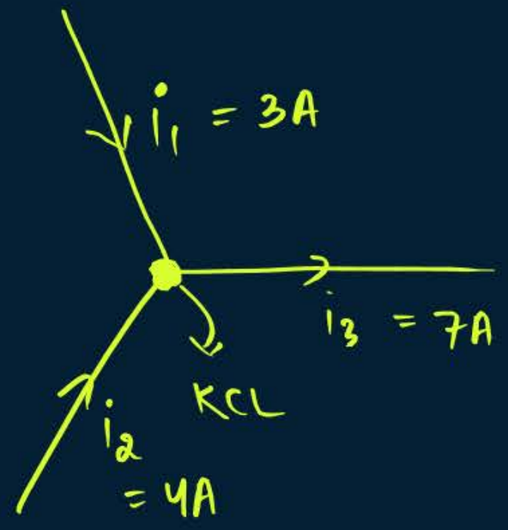
OR K.C.L.

- The algebraic sum of the currents meeting at a junction is zero.
- It is based on the conservation of charge

$$\sum i_{net} = 0$$

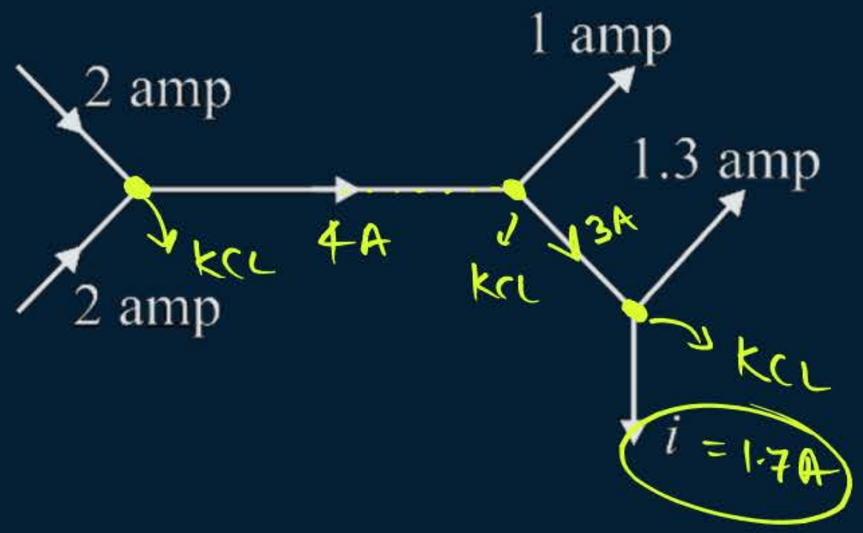
$$i_{incoming} = i_{outgoing}$$

$$\boxed{i_1 + i_2 = i_3}$$



QUESTION

The figure below shows currents in a part of electric circuit. The current *i* is



(A) 1.7 amp

(B) 3.7 amp

(C) 1.3 amp

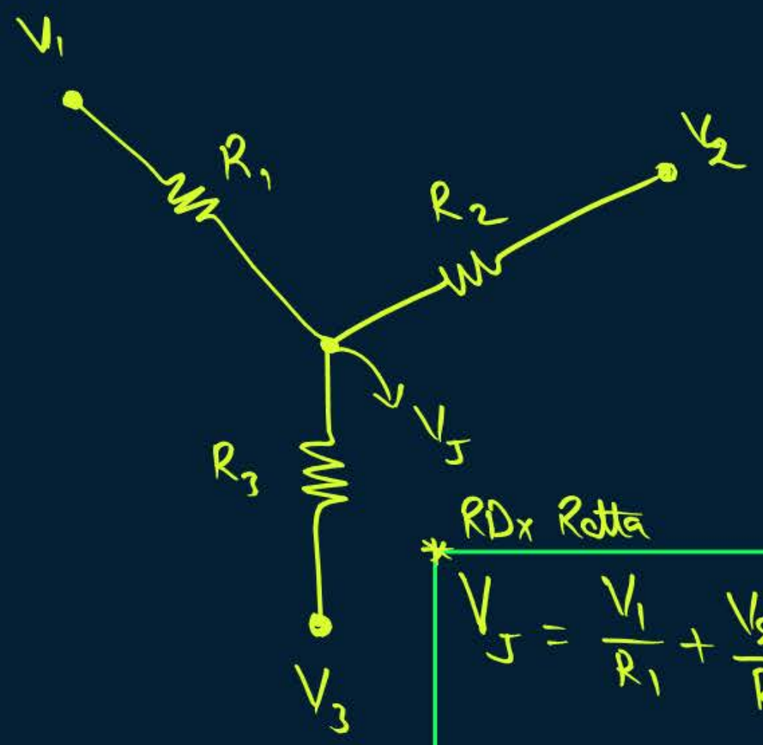
(D) 1 amp

Junction Potential

Ch-2

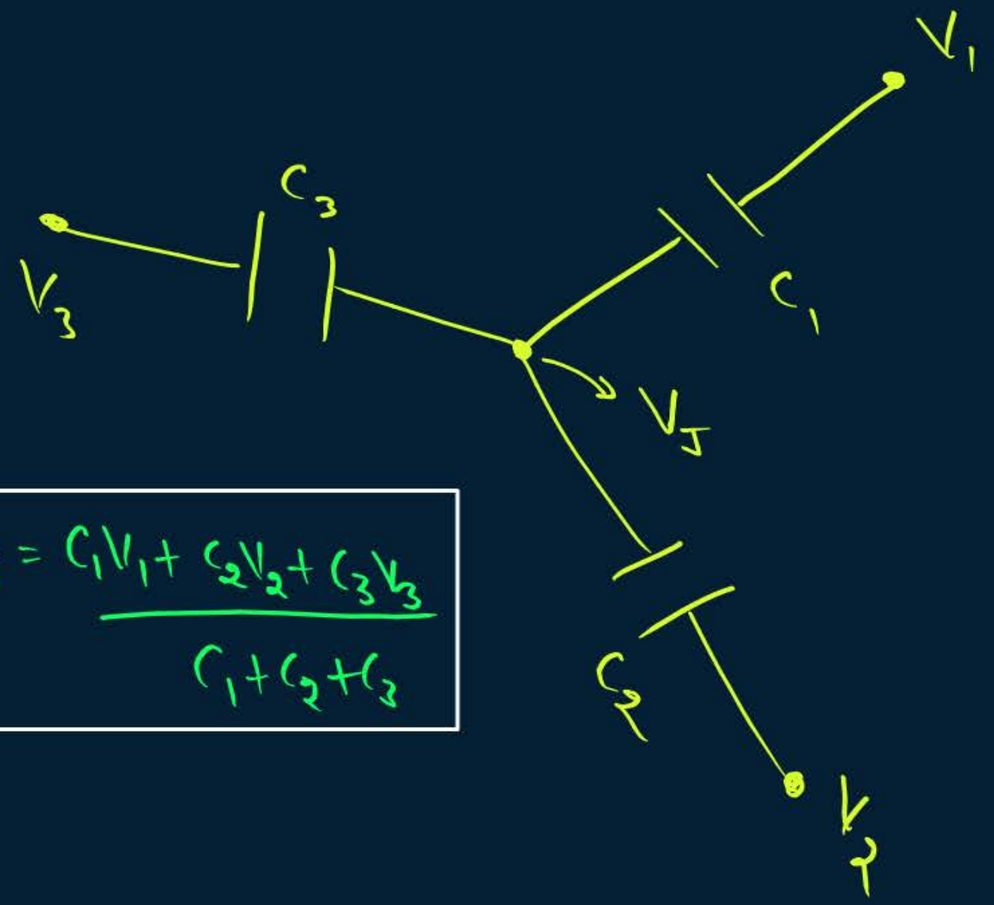
$C = \frac{1}{R}$

Y.K.B.



RDx Rotta

$$V_J = \frac{\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$



$$V_J = \frac{C_1V_1 + C_2V_2 + C_3V_3}{C_1 + C_2 + C_3}$$

2. Voltage (Loop) Law

K.V.L.

- The algebraic sum of the potential differences in a closed loop containing resistors, capacitors, batteries etc. is zero.
- It is based on the conservation of energy.

$$\sum_{\text{closed loop}} \Delta V = 0$$

QUESTION

Kirchhoff's first and second laws for electrical circuits are consequences of [2006]

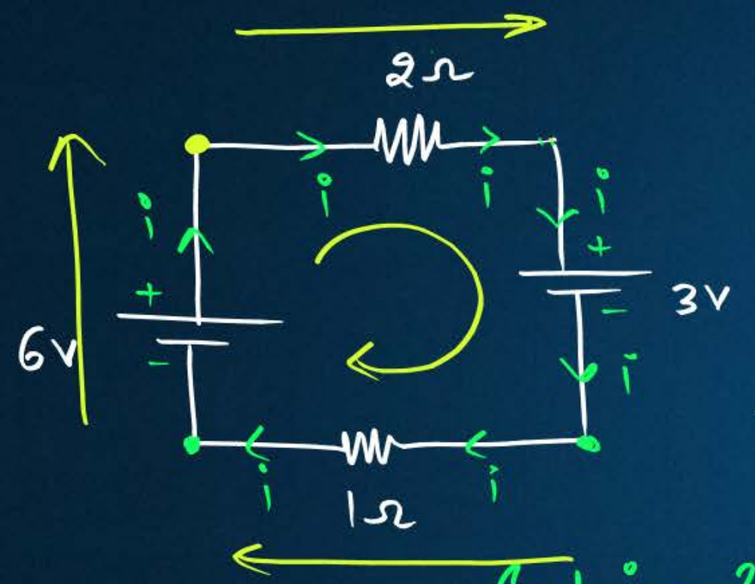
(A) conservation of electric charge and energy respectively

(B) conservation of electric charge

(C) conservation of energy and electric charge respectively

(D) conservation of energy

K.V.L.

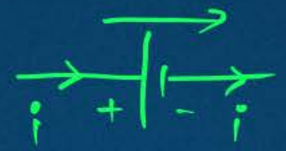


find $i = ?$

I) i ki direction mein lo.

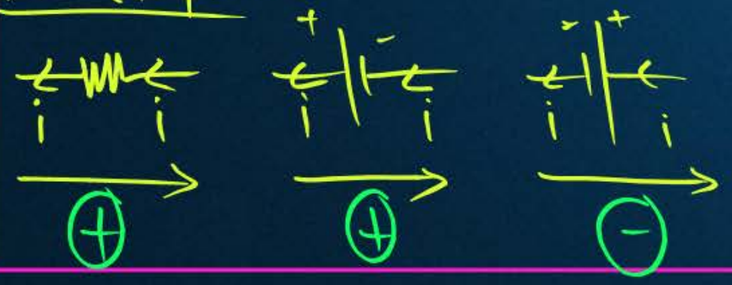
II) i ki direction mein traversing karo

III) R par V drop karna (−ve sign)

IV)  High Pot to Low Pot., V drop (−ve)

V) Lower Pot. to higher Pot., V rise (+ve)

RDx Exception



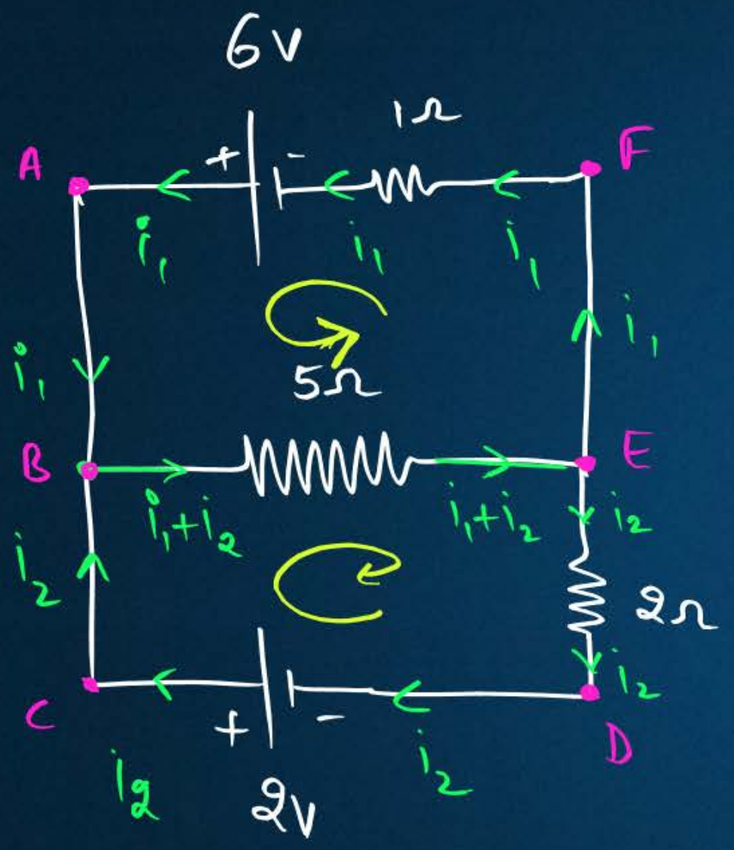
$$-i\times 2 - 3 - i\times 1 + 6 = 0$$

$$-2i - 3 - i + 6 = 0$$

$$-3i + 3 = 0$$

$$3 = 3i \qquad i = 3/3 = 1A$$

$i = 1A$ ✓



In loop ABEFA

$$-(i_1+i_2)5 - i_1 \times 1 + 6 = 0 \quad \cdots (i)$$

In loop CBEDC

$$-(i_1+i_2)5 - i_2 \times 2 + 2 = 0 \quad \cdots (ii)$$

Sol

$$-5i_1 - 5i_2 - i_1 + 6 = 0$$

$$-6i_1 - 5i_2 + 6 = 0 \quad \text{——— (A)}$$

$$-5i_1 - 5i_2 - 2i_2 + 2 = 0$$

$$-5i_1 - 7i_2 + 2 = 0 \quad \text{——— (B)}$$

$$(-6i_1 - 5i_2 + 6 = 0) \times 5$$
$$(-5i_1 - 7i_2 + 2 = 0) \times 6$$

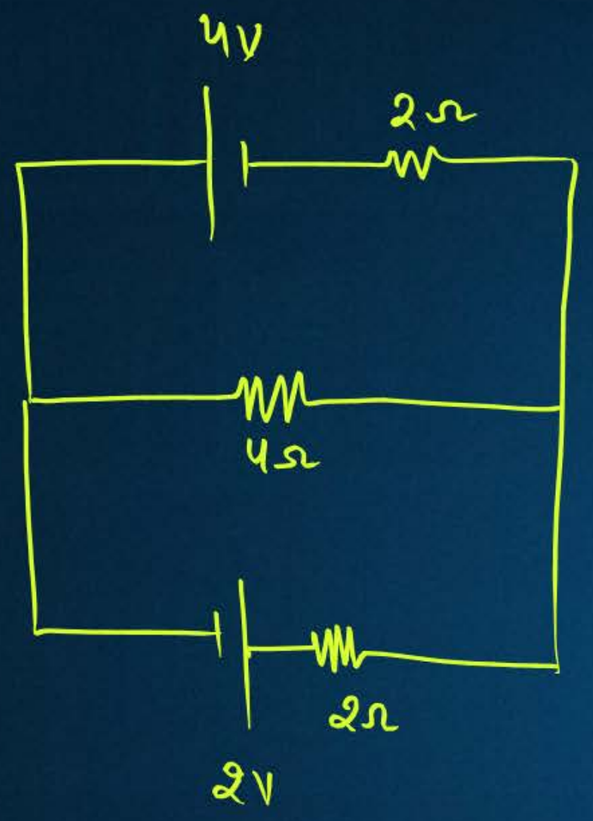
$$-30i_1 - 25i_2 + 30 = 0$$
$$-30i_1 - 42i_2 + 12 = 0$$
$$+ \qquad + \qquad -$$

$$+17i_2 + 18 = 0$$

$$17i_2 + 18 = 0$$
$$17i_2 = -18$$
$$i_2 = -\frac{18}{17} A$$

NOT A WRONG ANS., Just the direction opp^n

H.W.
for Practice



$i_1, i_2 = ?$

PARISHRAM

2026

Lecture - 06

Current Electricity

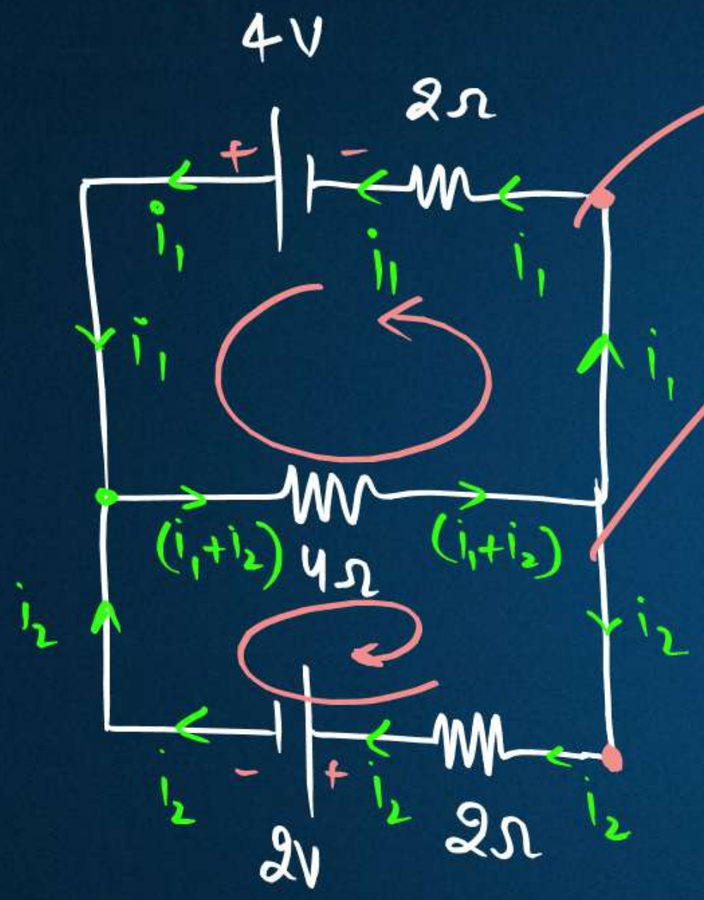
PHYSICS **LECTURE - 06**

BY - RAKSHAK SIR

Topics *To be covered*

- A Cells in Combination, EMF
- B
- C
- D

H.W.



$$-2i_1 + 4 - (i_1+i_2)4 = 0 \quad \cdots (1)$$

$$-2i_2 - 2 - (i_1+i_2)4 = 0 \quad \cdots (2)$$

$$-2i_1 + 4 - 4i_1 - 4i_2 = 0$$

$$4 \times [-6i_1 - 4i_2 + 4 = 0] \text{ — (A)}$$

$$-2i_2 - 2 - 4i_1 - 4i_2 = 0$$

$$6 \times [-4i_1 - 6i_2 - 2 = 0] \text{ — (B)}$$

$$\cancel{-24i_1} - 16i_2 + 16 = 0$$

$$\cancel{-24i_1} - 36i_2 - 12 = 0$$

$$20i_2 + 28 = 0$$

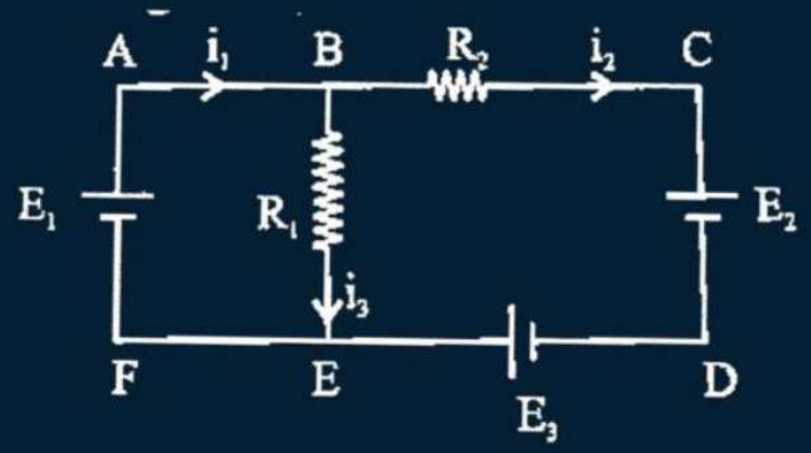
$$20i_2 + 28 = 0$$

$$i_2 = \frac{-28}{20} = \frac{-14}{10} = -1.4A$$

QUESTION

H.W.

For the circuit given below, the Kirchhoff's loop rule for the loop BCDEB is given by the equation [2020 Covid]



(A) $i_2R_2 + E_2 - E_3 - i_3R_1 = 0$

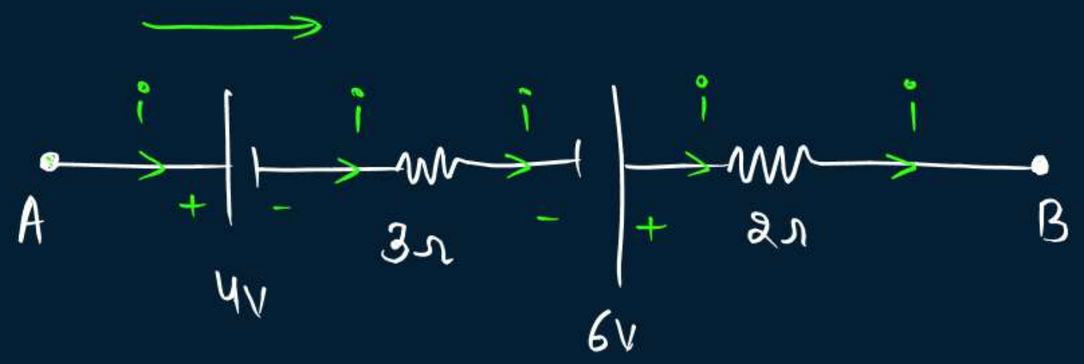
(B) $i_2R_2 + E_2 + E_3 - i_3R_1 = 0$

(C) $-i_2R_2 + E_2 + E_3 - i_3R_1 = 0$

(D) $-i_2R_2 + E_2 - E_3 - i_3R_1 = 0$

$\Delta V = V_A - V_B$

Finding Potential Difference between two points



$$V_A - 4 - 3i + 6 - 2i = V_B$$

$$V_A - V_B = +4 + 3i - 6 + 2i$$

$$\boxed{\Delta V = 5i - 2}$$

QUESTION

The potential difference ($V_A - V_B$) between the point A and B in the given figure is

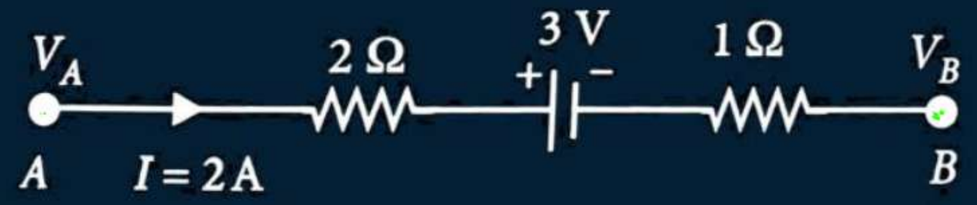
[NEET 2016]

(A) –3 V

(B) +3 V

(C) + 6

(D) + 9V



$V_A - 4 - 3 - 2 = V_B$

$V_A - 9 = V_B$

$V_A - V_B = +9$

$\Delta V = +9V$

QUESTION

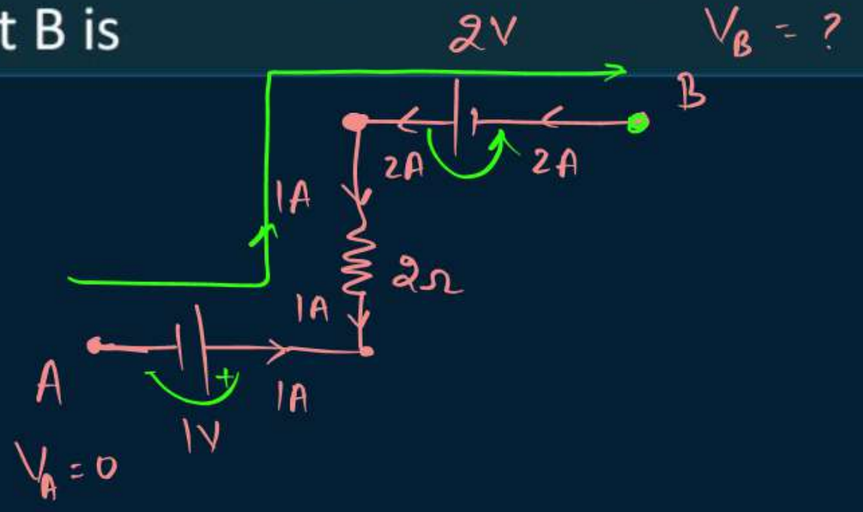
In the circuit shown in the figure, if the potential at point A is taken to be zero, the potential at point B is

(A) +1 V

(B) −1 V

(C) +2 V

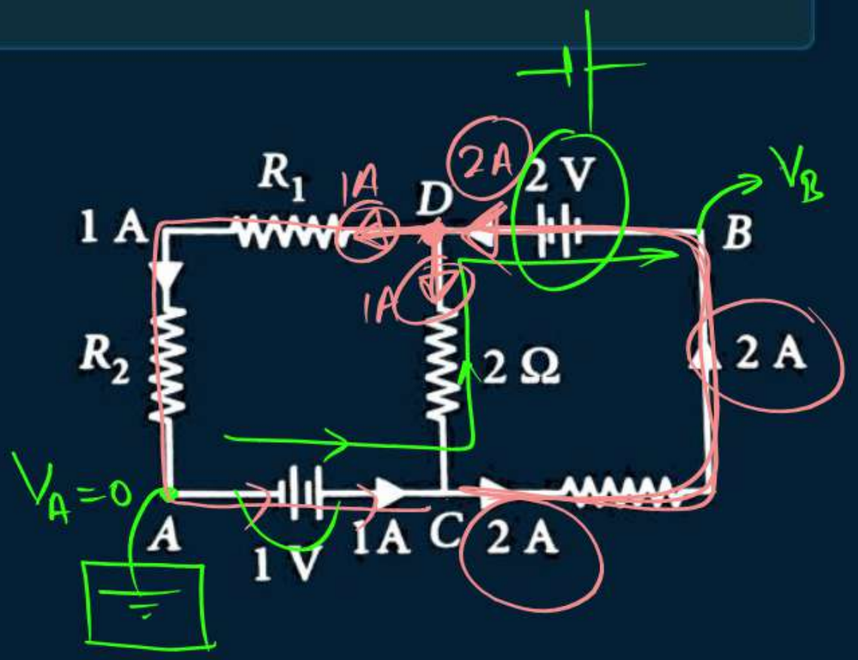
(D) −2 V



$V_A + 1 + \cancel{2} - \cancel{2} = V_B$

$0 + 1 = V_B$

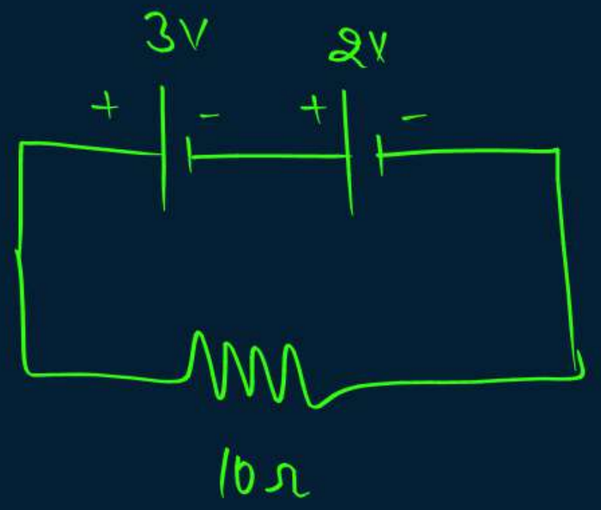
$V_B = 1$



Supporting and Opposing Batteries

Sister - Battery (Masi - Mummy)

Saas - bahu (Eka - kapoor)

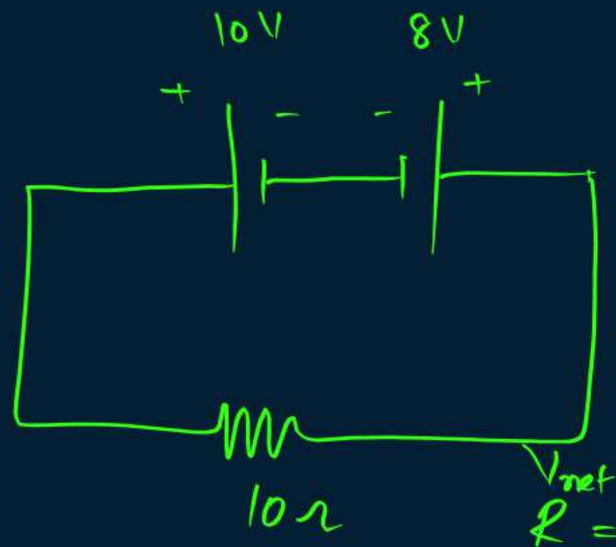


$V_{net} = 3 + 2 = 5V$

$R = 10\Omega$

$i = \frac{V}{R} = \frac{5}{10}$

$i = \frac{1}{2} A$



$V_{net} = 10 - 8 = 2V$

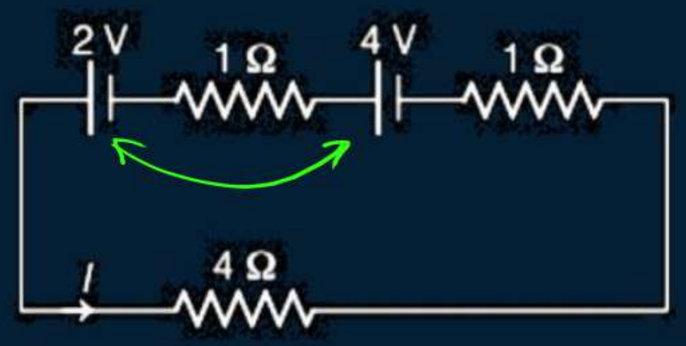
$R = 10\Omega$

$i = \frac{V}{R} = \frac{2}{10}$

$= 0.2A$

QUESTION

For the circuit shown in the figure, the current *I* will be [NEET (Oct.) 2020]



(A) 0.75 A

(B) 1 A

(C) 1.5 A

(D) 0.5 A

$V = 6V$

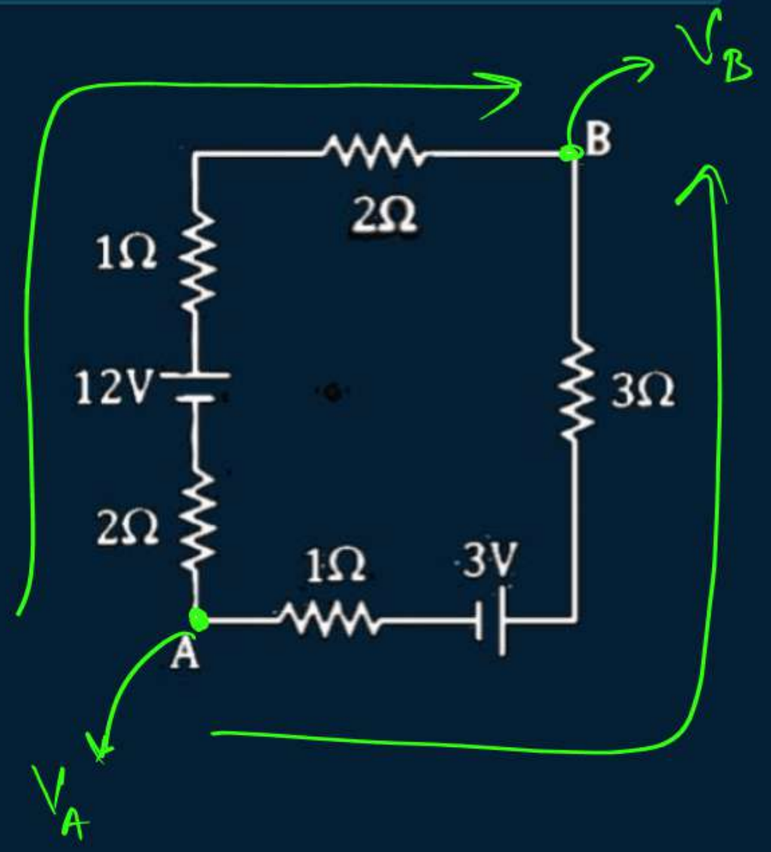
$R_{total} = 4 + 1 + 1 = 6\Omega$

$i = \frac{V}{R} = \frac{6}{6} = 1A$

QUESTION

H.W.

Potential difference $V_B - V_A$ in the network shown in



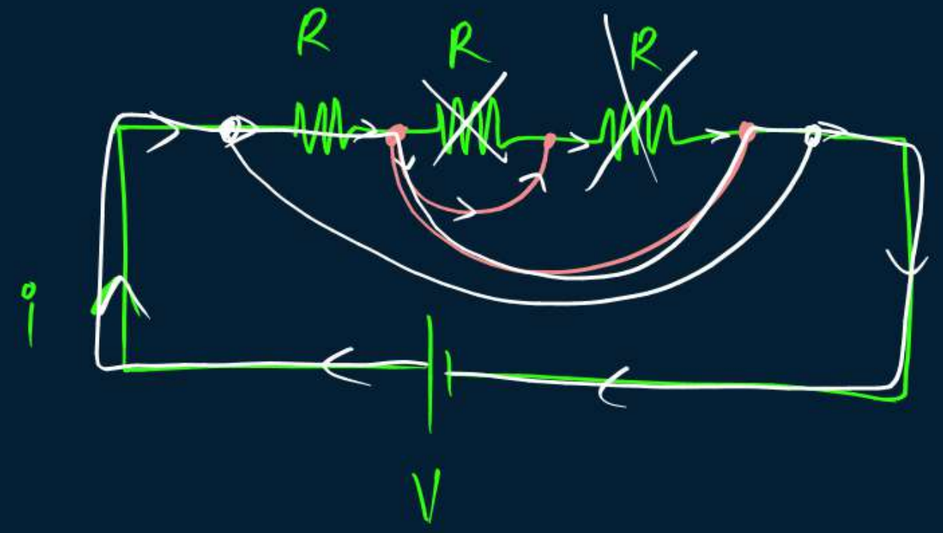
(A) 7 V

(B) 6 V

(C) 5 V

(D) 8 V

Short Circuiting



$i = \frac{V}{R_t}$

$i = \frac{V}{3R}$

$i \uparrow = \frac{V}{2R} \downarrow$ same

$i \uparrow = \frac{V}{R} \downarrow$

$i = \frac{V}{0}$

$i \to \infty$

Short circuit

Ckt overloading

fire

QUESTION

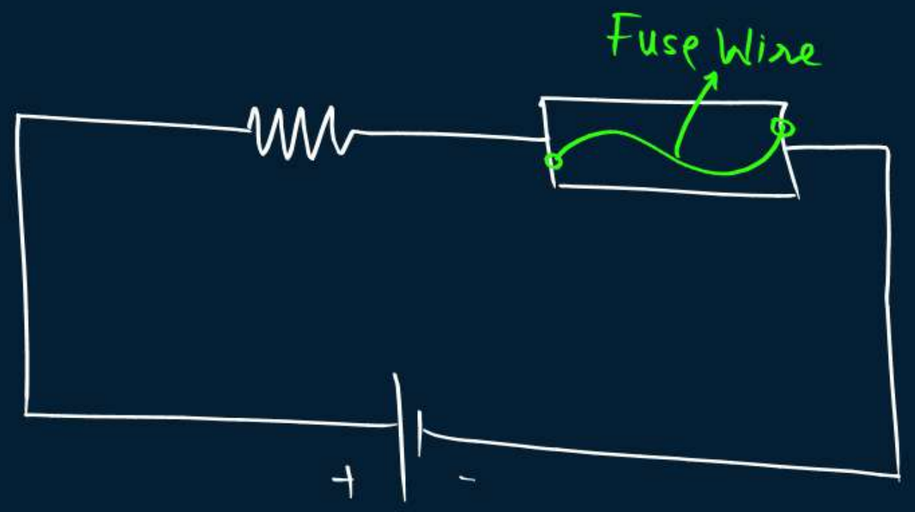
Which of the following acts as a circuit protection device? [2019]

(A) Conductor

(B) Inductor

(C) Switch

(D) Fuse



Fuse is a $\boxed{\text{ckt. breaker}}$

↓

Fuse Wire → Melt Hona Acha hai

(Sn-Pb Alloy)

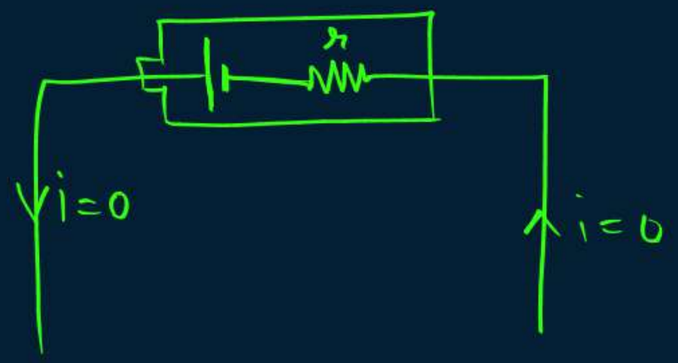
or

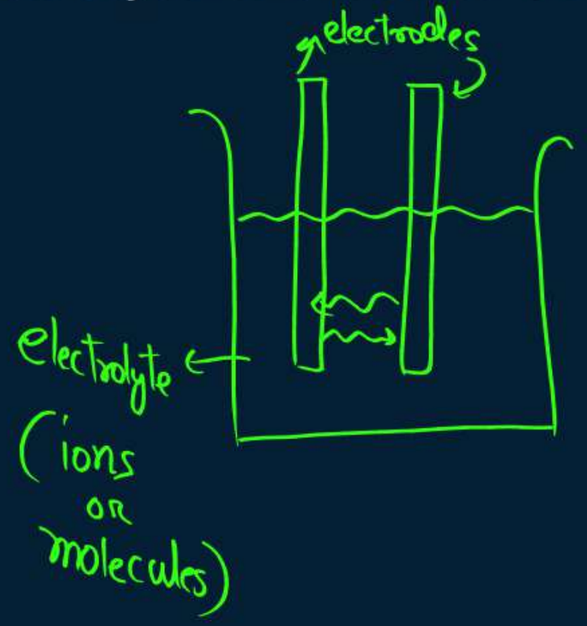
((Cu-Ni Alloy)

Batteriya

A battery or cell is a device which maintains constant potential difference in a circuit. Combination of cells is called battery.

Internal resistance is the resistance offered by the electrolyte of a cell to the charge flow.





($\mathcal{E}$)

EMF - Maximum Potential difference given by a cell in an open circuit.

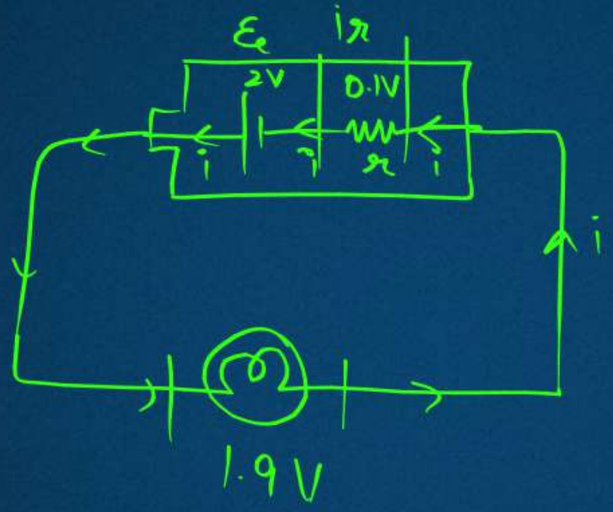
↓

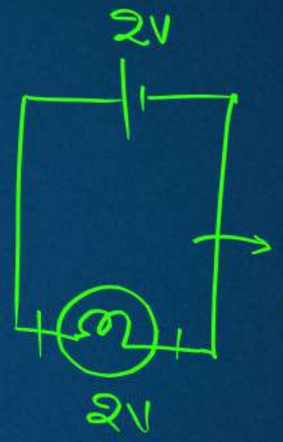
Electro-motive Force

↓

This is Not a Force,

this is Voltage





This is Galat-fehmi

$V = ir$

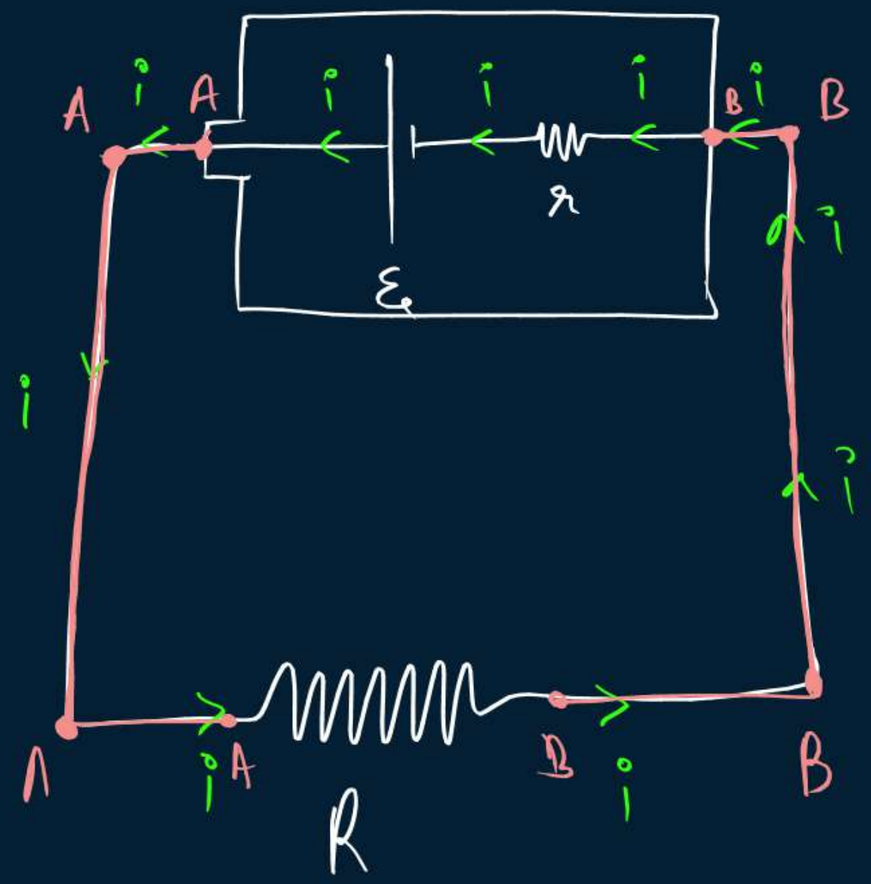
$= 0 \times r$

$V = 0$

When $i = 0$, 'r' has no role to play, $V = \mathcal{E}$

Discharging Circuit

→ Current is supplied by cell



$$i = \frac{\text{Pot. Diff}}{\text{total } R}$$

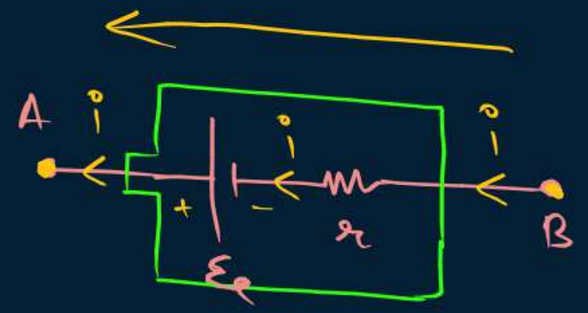
$$\boxed{i = \frac{\varepsilon}{R+r}}$$

V_{AB} (T.P.D.)

T.P.D. (Terminal P.d.)

it is the actual P.d. offered by a cell.

$$V_{AB}\left(\text{across } R\right) = V_{AB}\left(\text{Across cell}\right)$$



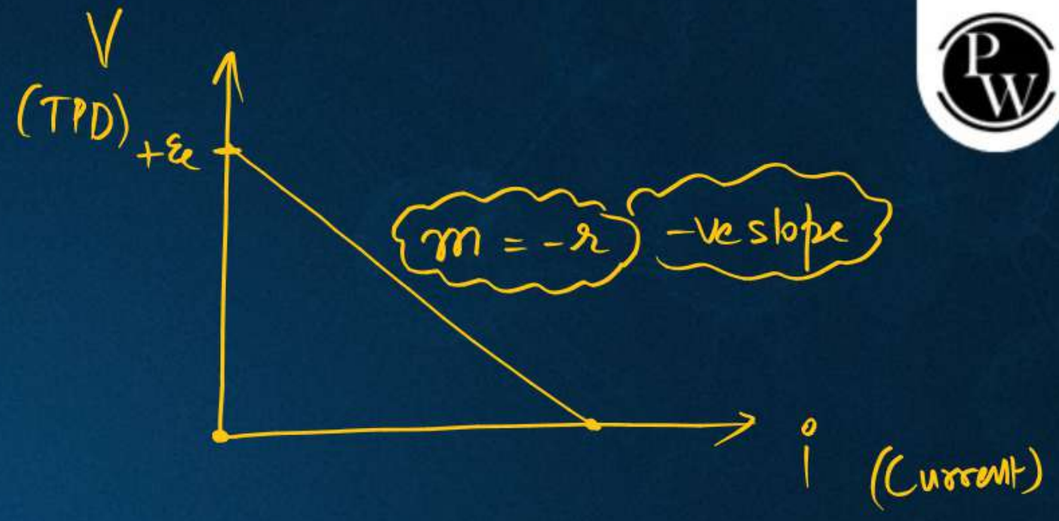
$$V_B - ir + \varepsilon = V_A$$

$$\varepsilon - ir = V_A - V_B$$

$$\varepsilon - ir = \Delta V_{AB}$$

T.P.D. during discharge ← $\boxed{V = \varepsilon - ir}$

$$\boxed{V = \mathcal{E} - ir}$$



Spl. case :-

open ckt. $(i = 0)$: Disconnected cell

$$\boxed{V = \mathcal{E} - ir}$$

$i = 0$

$V = \mathcal{E} - (0)r$

$$\boxed{V = \mathcal{E}}$$

T.P.D. $= \mathcal{E}$.m.f.

$V = \mathcal{E} - ir$

$y = c + mx$

$V = \mathcal{E} - ri$

$y \to V$

$x \to i$

toh

$m = -r$	slope $= -r$
$c = +\mathcal{E}$	intercept $= +\mathcal{E}$

QUESTION

H.W.

The e.m.f. of a cell is E volts and internal resistance is *r* ohm. The resistance in external circuit is also *r* ohm. The p.d. across the cell will be

(A) E/2

(B) 2E

(C) 4E

(D) E/4

QUESTION

H.W.

The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is **[NEET 2013]**

(A) 0.2 Ω

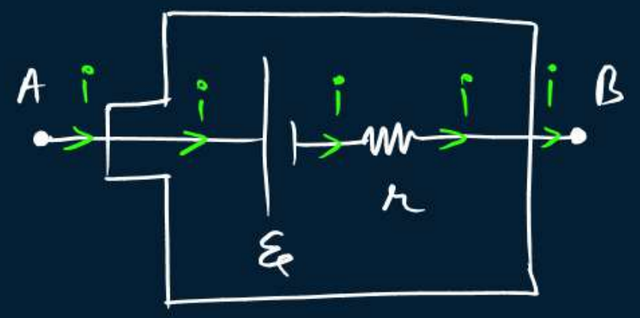
(B) 0.5 Ω

(C) 0.8 Ω

(D) 1.0 Ω

Charging Circuit

Current is supplied to cell.



T.P.D. (Terminal P.d.)

$$V_A - \varepsilon - ir = V_B$$

$$V_A - V_B = \varepsilon + ir$$

$$\Delta V = \varepsilon + ir$$

$$\boxed{V = \varepsilon + ir}$$

Spl. case : $i = 0$

$$V = \varepsilon$$

Graph of charging ckt.

$$V = \mathcal{E} + ir$$

$$V = \mathcal{E} + ri$$

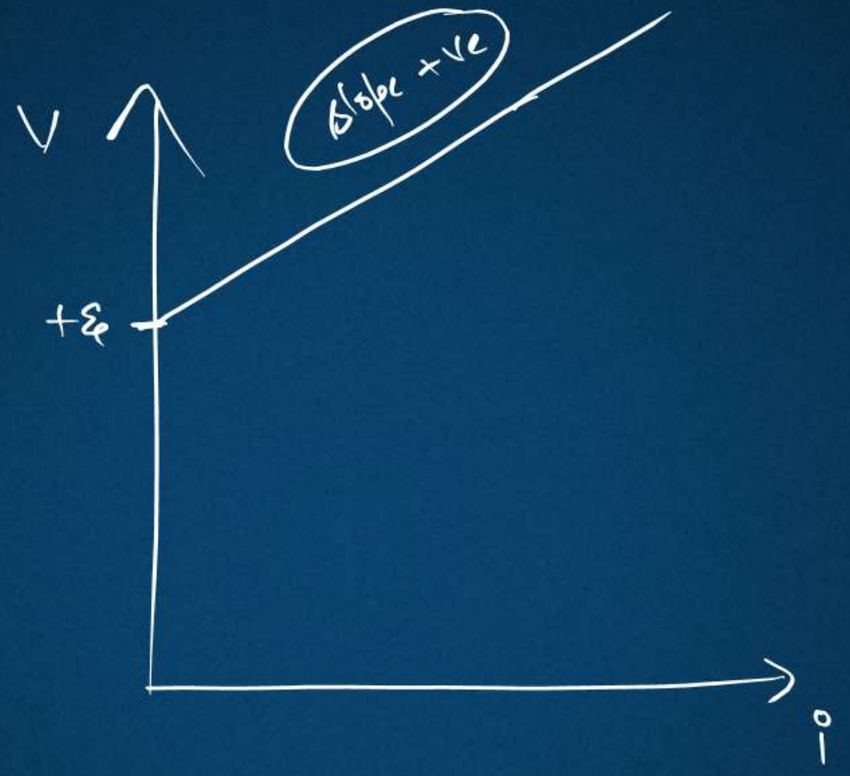
$$y = c + mx$$

$y \rightarrow V$

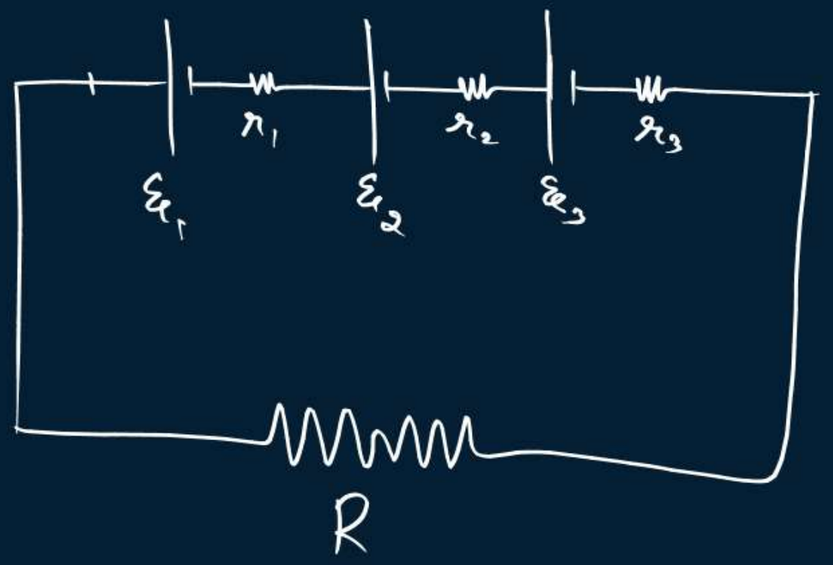
$x \rightarrow i$

$m = +r$

$c = +\mathcal{E}$



Cells in Combination – 1. Series



$$\boxed{\mathcal{E}_{net} = \mathcal{E}_1 + \mathcal{E}_2 + \mathcal{E}_3 + \ldots\ldots \mathcal{E}_n}$$

$$\boxed{r_{net} = r_1 + r_2 + r_3 + \ldots\ldots r_n}$$

$$R_{total} = r_{net} + R$$

$$i_{total} = \frac{\text{Pot. diff}}{\text{total Resi}}$$

$$\boxed{i_{net} = \frac{\mathcal{E}_{net}}{R + r_{net}}}$$

Spl. case

n – identical cells

$$\mathcal{E}_{net} = \underbrace{\mathcal{E} + \mathcal{E} + \mathcal{E} + \mathcal{E} + \ldots}_{n}$$

$$\boxed{\mathcal{E}_{net} = n\mathcal{E}}$$

$$r_{net} = \underbrace{r + r + r + r + \ldots}_{n}$$

$$\boxed{r_{net} = nr}$$

$$R_{total} = R + nr$$

$$\boxed{i_{net} = \frac{n\mathcal{E}}{R + nr}}$$

QUESTION

H.W.

n identical cells each of e.m.f. E and internal resistance r are connected in series. An external resistance R is connected in series to this combination. The current through R is

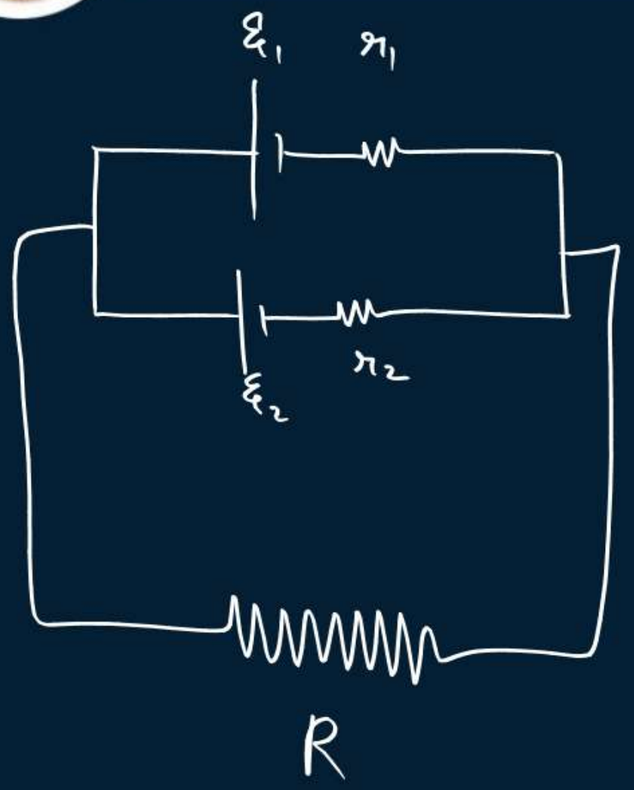
(A) $\frac{nE}{R+nr}$

(B) $\frac{nE}{nR+r}$

(C) $\frac{E}{R+nr}$

(D) $\frac{nE}{R+r}$

2. Parallel Combination



$$\mathcal{E}_{net} = \frac{\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$$

$$r_{net} = \frac{r_1 r_2}{r_1 + r_2}$$

$$R_{total} = R + r_{net}$$

$$i_{total} = \frac{\mathcal{E}_{net}}{R + r_{net}}$$

Spl. case

n - identical cells

$$\mathcal{E}_{net} = \frac{\frac{\mathcal{E}}{r} + \frac{\mathcal{E}}{r} + \frac{\mathcal{E}}{r} + \frac{\mathcal{E}}{r} \cdots n}{\frac{1}{r} + \frac{1}{r} + \frac{1}{r} + \frac{1}{r} \cdots n}$$

$$\mathcal{E}_{net} = \frac{\frac{\cancel{n}\mathcal{E}}{\cancel{r}}}{\frac{\cancel{n}}{\cancel{r}}} = \mathcal{E}$$

$$\mathcal{E}_{net} = \mathcal{E}$$

Note - if n cells of $\mathcal{E}$ emf is connected, $\mathcal{E}_{net} = \mathcal{E}$

$$\frac{1}{r_{net}} = \frac{1}{r} + \frac{1}{r} + \frac{1}{r} + \frac{1}{r} \cdots n$$

$$\frac{1}{r_{net}} = \frac{n}{r} \longrightarrow r_{net} = \frac{r}{n}$$

$$i_{net} = \frac{\mathcal{E}_{net}}{R + r_{net}}, \quad i_{net} = \frac{\mathcal{E}}{R + \frac{r}{n}}$$

Homework

- Backlog ✓
- Revision + Notes + Practice Ques. ✓
- D.P.P. (Try)

PARISHRAM

2026

Lecture - 07

Current Electricity

PHYSICS | **Lecture - 7**

BY - RAKSHAK SIR

Topics *to be covered*

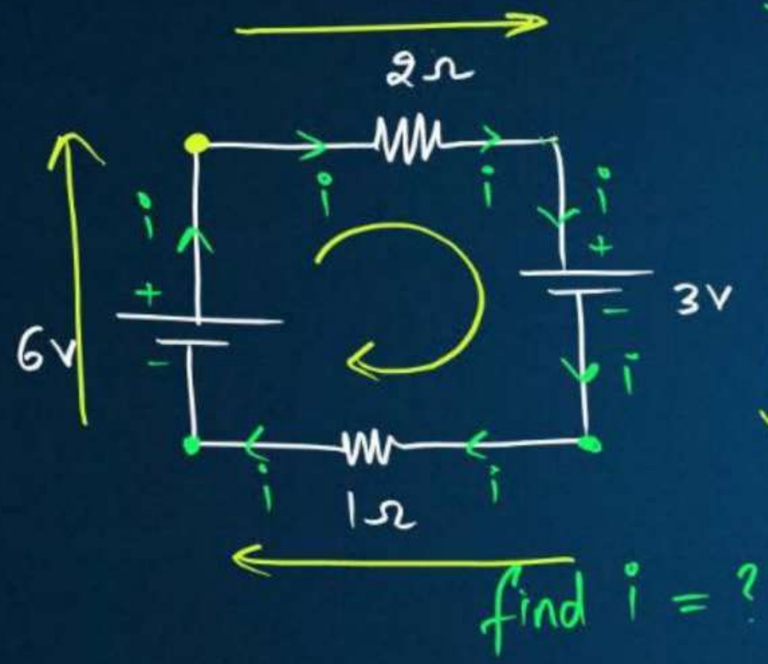
A Heating Effects and Power

B Energy

C

D

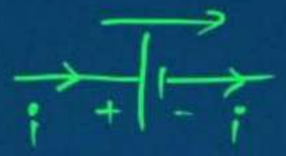
K.V.L.

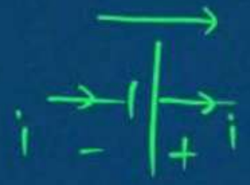


I) i ki direction mein lo.

II) i ki direction mein traversing karo

III) R par V drop karna (−ve sign)

IV)  High Pot to Low Pot., V drop (−ve)

V)  Lower Pot. to higher Pot., V rise (+ve)

RDx Exception

$$-i\times 2 - 3 - i\times 1 + 6 = 0$$

$$-2i - 3 - i + 6 = 0$$

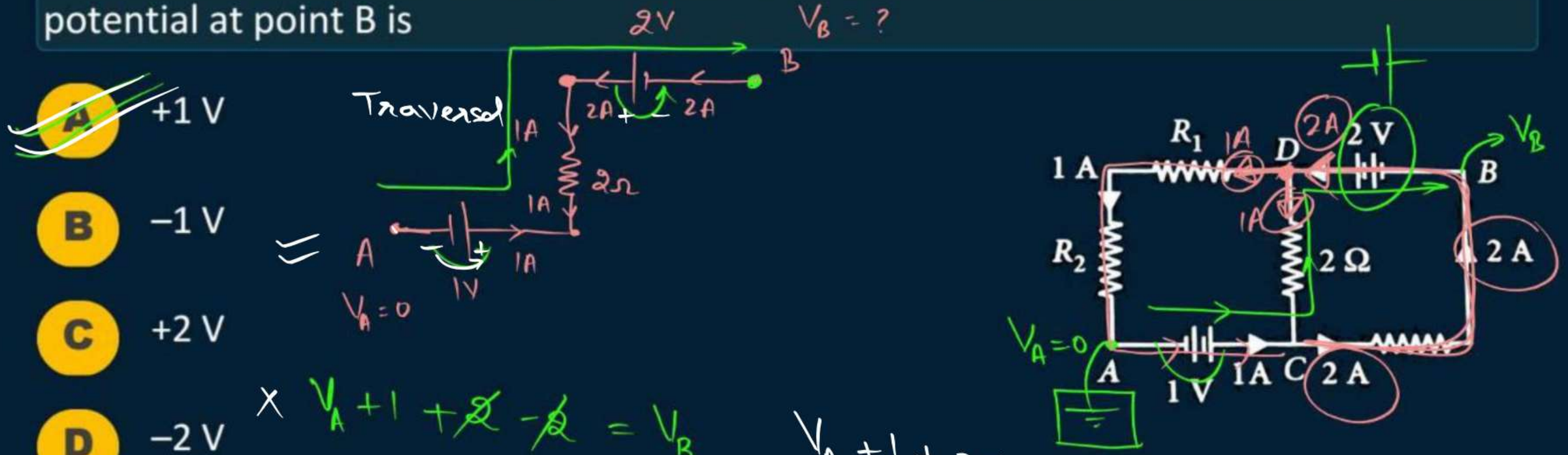
$$-3i + 3 = 0$$

$$3 = 3i \qquad i = 3/3 = 1A$$

$i = 1A$ ✓

QUESTION

In the circuit shown in the figure, if the potential at point A is taken to be zero, the potential at point B is



(A) +1 V

(B) −1 V

(C) +2 V

(D) −2 V

$V_A + 1 + \cancel{2} - \cancel{2} = V_B$

$0 + 1 = V_B$

$V_B = 1$

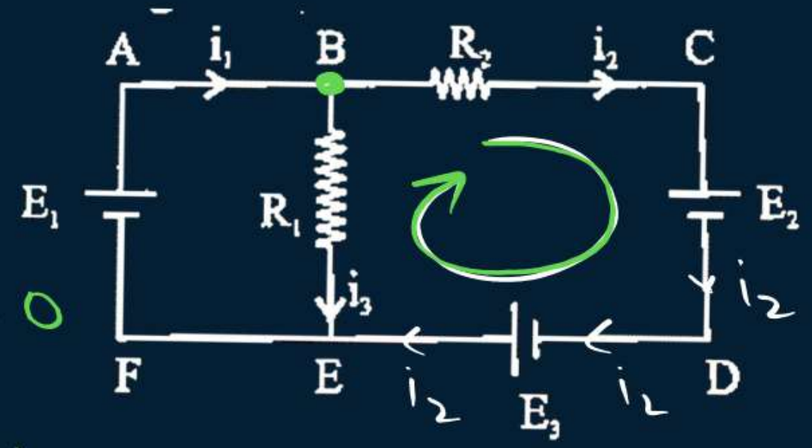
$V_A + 1 + 2\times1 - 2 = V_B$

$0 + 1 + \cancel{2} - \cancel{2} = V_B$

$1 = V_B$

HW QUESTION

For the circuit given below, the Kirchhoff's loop rule for the loop BCDEB is given by the equation **[2020 Covid]**



(A) $i_2R_2 + E_2 - E_3 - i_3R_1 = 0$

(B) $i_2R_2 + E_2 + E_3 - i_3R_1 = 0$

(C) $-i_2R_2 + E_2 + E_3 - i_3R_1 = 0$

(D) $-i_2R_2 + E_2 - E_3 - i_3R_1 = 0$

$-i_2R_2 - E_2 + E_3 + i_3R_1 = 0$

$-1(+i_2R_2 + E_2 - E_3 - i_3R_1) = 0$

$i_2R_2 + E_2 - E_3 - i_3R_1 = 0$

HW QUESTION

$i = \frac{\mathcal{E}_{net}}{R_{net}} = \frac{12-3}{9} = \frac{9}{9} = 1A$

Potential difference $V_B - V_A$ in the network shown in

(A) 7 V

(B) 6 V

(C) 5 V

(D) 8 V

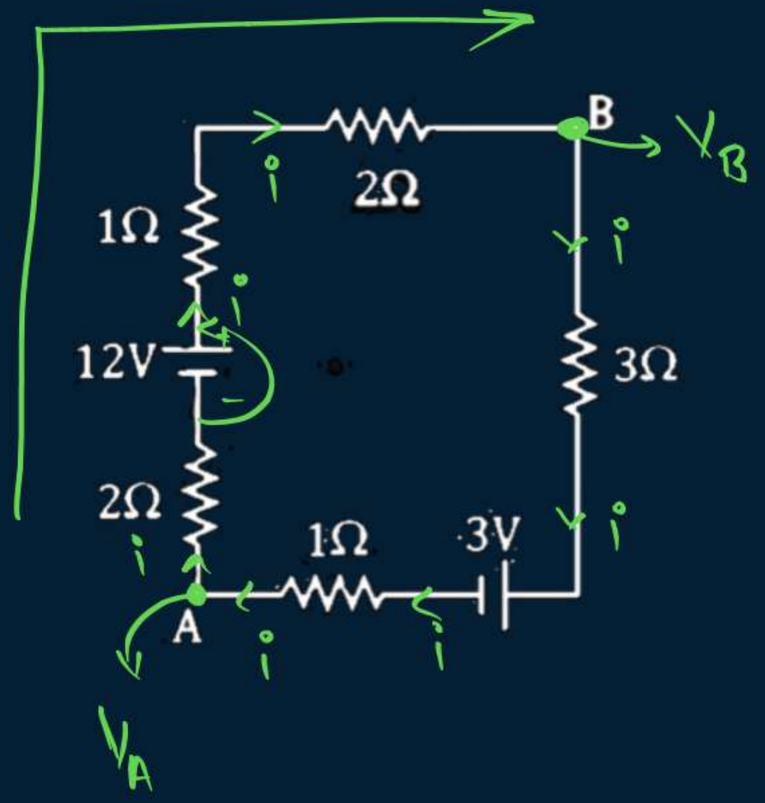
$V_A - 2i + 12 - i - 2i = V_B$

$-5i + 12 = V_B - V_A$

$-5(1) + 12 = V_B - V_A$

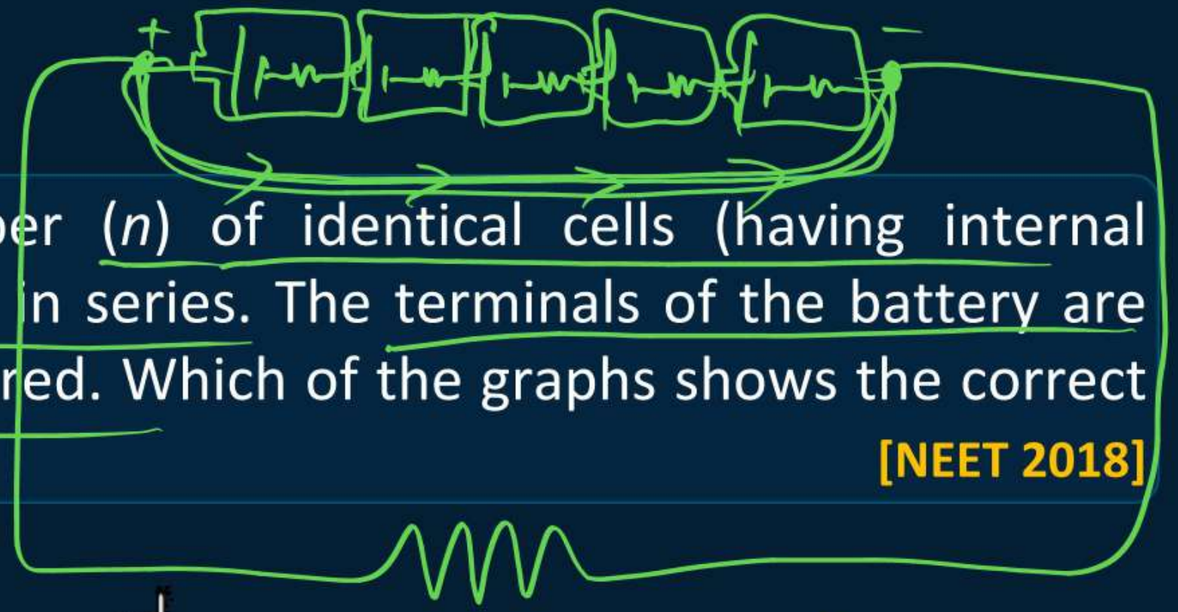
$-5 + 12 = V_B - V_A$

$7V = V_B - V_A$



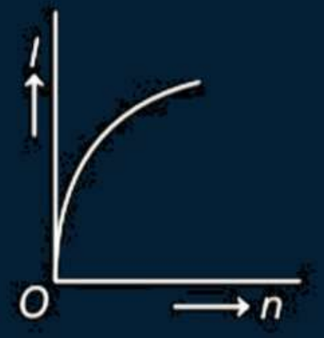
QUESTION

A battery consists of a variable number (n) of identical cells (having internal resistance 'r' each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n? **[NEET 2018]**

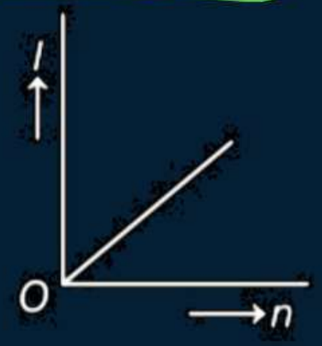


$I \to \infty$

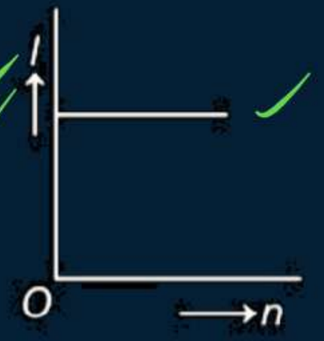
A



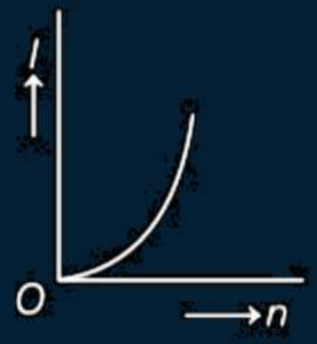
B



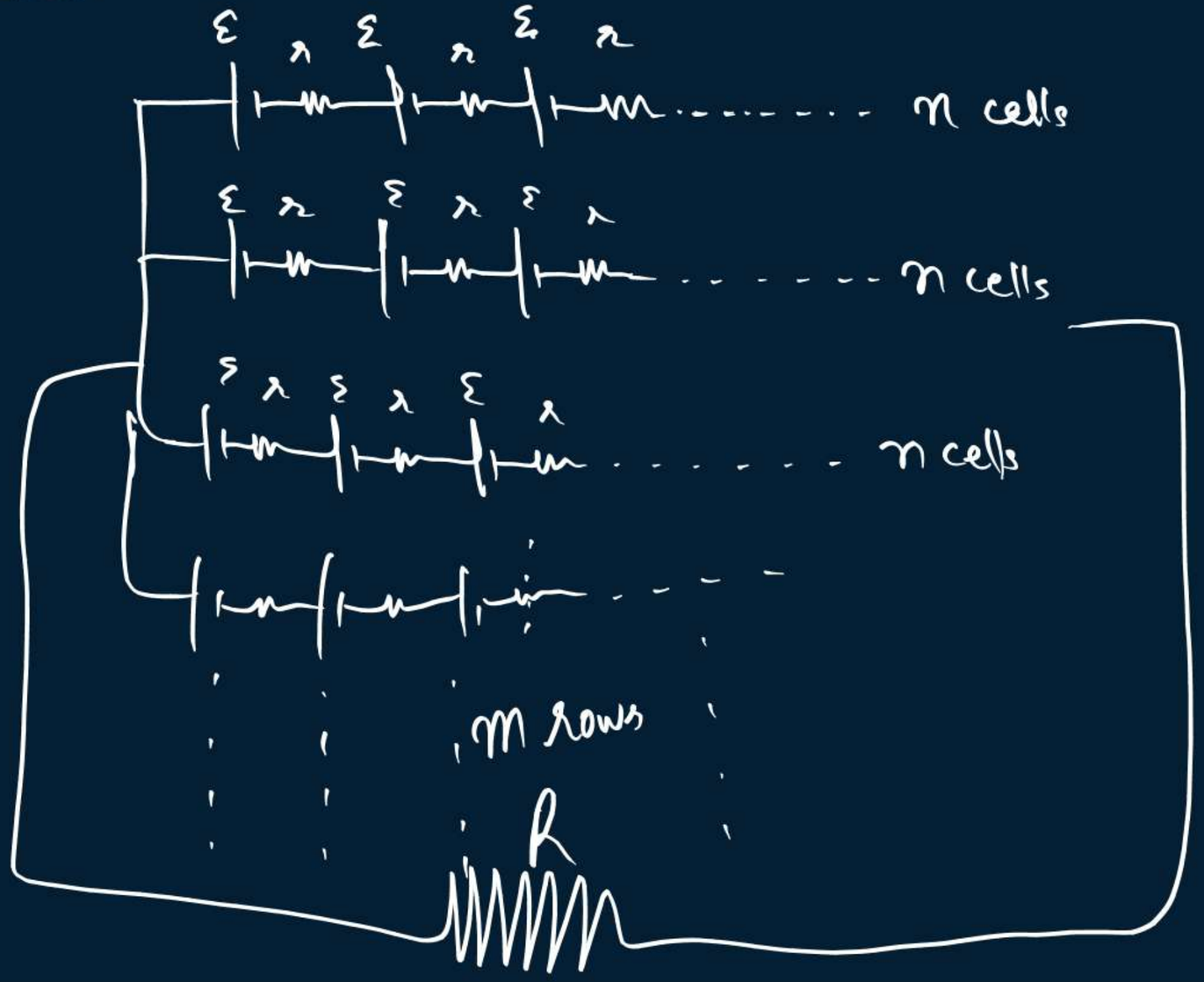
C



D



3. Mixed Grouping or Combination & MPT



$$\boxed{\varepsilon_{net} = n\varepsilon}$$

$$\boxed{r_{net} = \frac{nr}{m}}$$

$$i = \frac{\varepsilon_{net}}{R_{net}} = \frac{\varepsilon_{net}}{R + r_{net}}$$

$$\boxed{i = \frac{n\varepsilon}{R_L + \frac{nr}{m}}}$$

Spl. case :-

* "Maximum Power Transfer" Theorem :-

When load resistance becomes equal to net internal resistance Power Transfer maximises from cells to load.

When $r_{net} = R_L$, Power → Maximise

$$i = \frac{n\varepsilon}{2nr/m} = \frac{m\varepsilon}{2r}$$

QUESTION

A cell of internal resistance *r* drives current through an external resistance R. The power delivered by the cell to the external resistance will be maximum when:

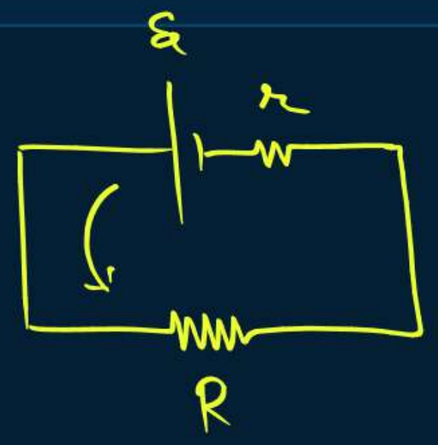
[10 Jan, 2019 (S-I)]

(A) R = 0.001 r

(B) R = 1000 r

(C) R = 2r

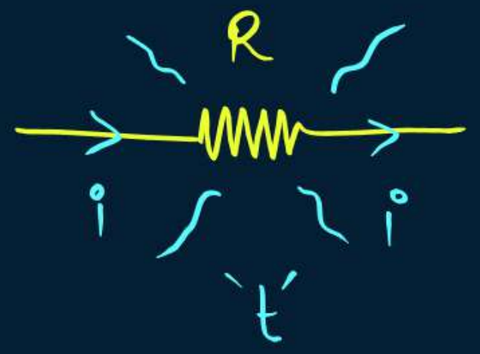
(D) R = r



By MPT · Theorem

$r = R$

Joule's Law of Heating Effect



Joule

$$H = i^2 R t \rightarrow P = i^2 R$$

$$H = V i t \rightarrow P = V i$$

$$H = \frac{V^2}{R} t \rightarrow P = \frac{V^2}{R}$$

Watt

$$\text{Power} = \frac{\text{Workdone}}{\text{time}}$$

$$\text{Electrical Power} = \frac{\text{Electrical Energy}}{\text{time}}$$

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

$$P \times t = E$$

QUESTION

$H = i^2 R t$

The H amount of thermal energy is developed by a resistor in 10 s when a current of 4 A is passed through it. If the current is increased to 16 A, the thermal energy developed by the resistor in 10 s will be: [31 Jan, 2023 (Shift-II)]

A. H

B. 16 H

C. H/4

D. 4H

$H_1 = H$ $\quad$ $H_2 = ?$

$t_1 = 10s$ $\quad$ $t_2 = 10s$

$i_1 = 4A$ $\quad$ $i_2 = 16A$

$R_1 = R$ $\quad$ $R_2 = R$

$H_1 = i_1^2 R_1 t_1$ $\quad$ $H_2 = i_2^2 R_2 t_2$

$H = (4)^2 \times R \times 10 \cdots (I)$ $\quad$ $H_2 = (16)^2 R \times 10 \cdots (II)$

Divide (II) by (I)

$\frac{H_2}{H} = \frac{(16)^2 \cancel{R} \times \cancel{10}}{(4)^2 \cancel{R} \cancel{10}} = (4)^2 = 16$

$H_2 = 16 H$

QUESTION

Match the Column-I with Column-II.

(A) A-(Q); B-(P); C-(R)

(B) A-(Q); B-(R); C-(P)

(C) A-(P); B-(Q); C-(R)

(D) A-(R); B-(Q); C-(P)

	Column-I		Column-II
A.	Power	P.	$V = IR$
B.	Ohm's law	Q.	$P = VI$
C.	Internal resistance of cell	R.	$r = \frac{E-V}{V} \times R$

$$r = \frac{E-V}{V} \times R$$

Power Rating & Power Consumed

P_r, V_r

It is the amount of Power which is dissipated when Connected across "220V"

P, V

Actual Power dissipated at any particular Voltage.

When connect at 220V,

Power = 60W

* RDx

$$P = P_r \left(\frac{V}{V_r}\right)^2$$

QUESTION

Garreeb

In India, electricity is supplied for domestic use at 220 V. It is supplied at 110 V is USA. If the resistance of a 60W bulb for use in India is R, the resistance of a 60W bulb for use in USA will be

[CBSE AIPMT 2004]

(A) R

(B) 2 R

(C) R/4

(D) R/2

$$P = \frac{V^2}{R}$$

India

$$60 = \frac{(220)^2}{R} \quad \cdots (1)$$

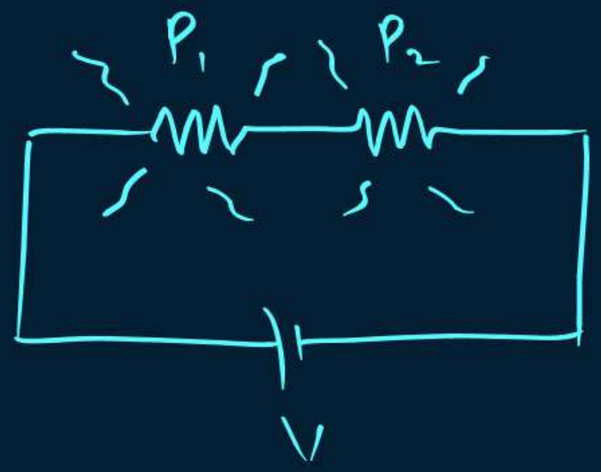
USA

$$60 = \frac{(110)^2}{R'} \quad \cdots (11)$$

equate (1) & (11)

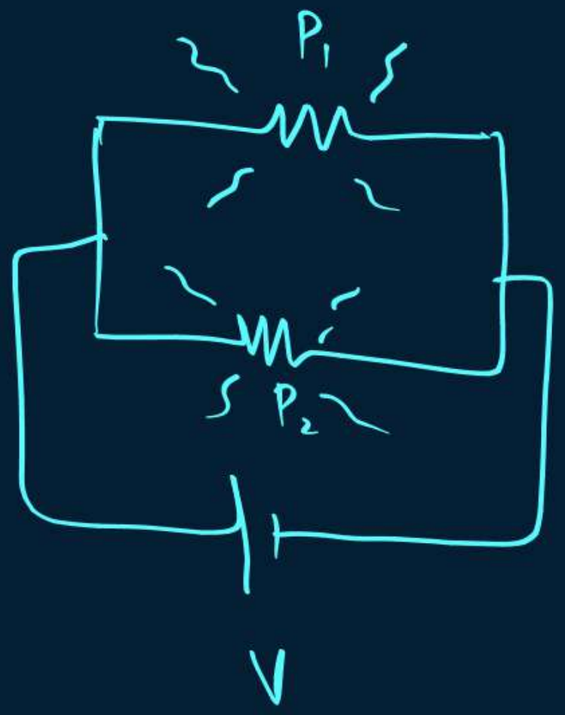
$$\frac{(220)^2}{R} = \frac{(110)^2}{R'} \rightarrow R' = R\left(\frac{110}{220}\right)^2 = R \times \frac{1}{4} = \frac{R}{4}$$

Total Power consumed in combination – Series & Parallel



$$P_{net} = P_1 + P_2$$

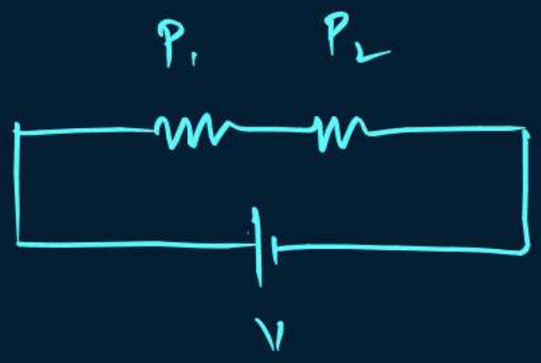
$$R_{net} = R_1 + R_2$$



$$P_{net} = P_1 + P_2$$

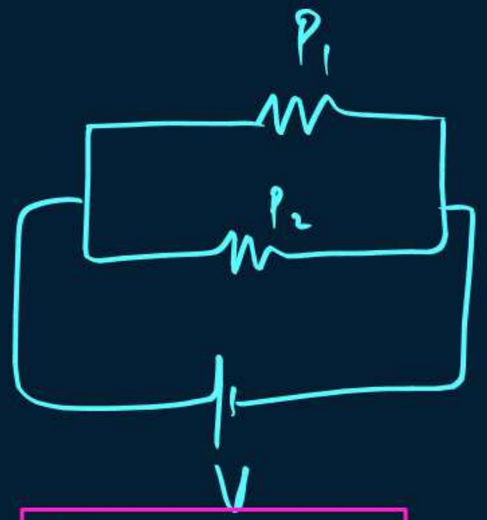
$$\frac{1}{R_{net}} = \frac{1}{R_1} + \frac{1}{R_2} \cdots$$

Total Power "Rated" in combination – Series & Parallel



$$\frac{1}{P_{net}} = \frac{1}{P_1} + \frac{1}{P_2}$$

$$R_{net} = R_1 + R_2$$



$$P_{net} = P_1 + P_2$$

$$\frac{1}{R_{net}} = \frac{1}{R_1} + \frac{1}{R_2}$$

QUESTION

consumed

The power dissipated in the circuit shown in the figure is 30 Watts. The value of R is [2012 M]

(A) 20 Ω

(B) 15 Ω

(C) 10 Ω

(D) 30 Ω

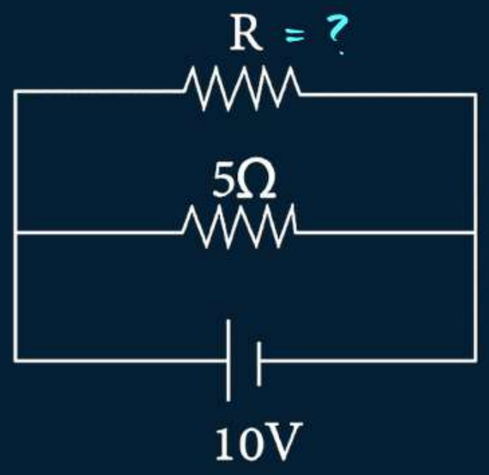
$$P_{net} = \frac{V^2}{R_{net}}$$

$$30 = \frac{(10)^2}{\left(\frac{5R}{5+R}\right)}$$

$$3\cancel{0} \times \frac{\cancel{5}R}{5+R} = \overset{2}{\cancel{10}}\cancel{0}$$

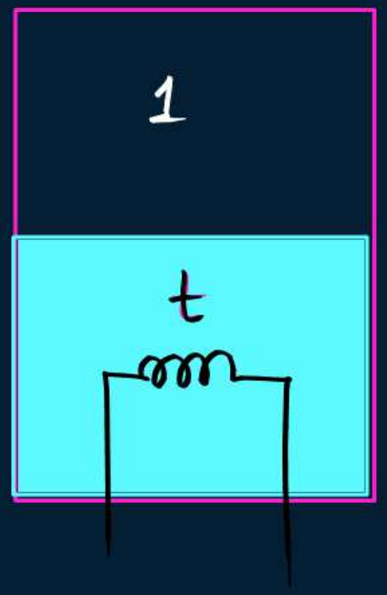
$$3R = 10 + 2R$$

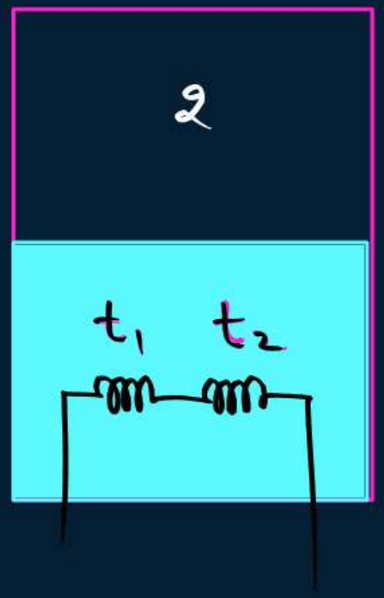
$$R = 10$$



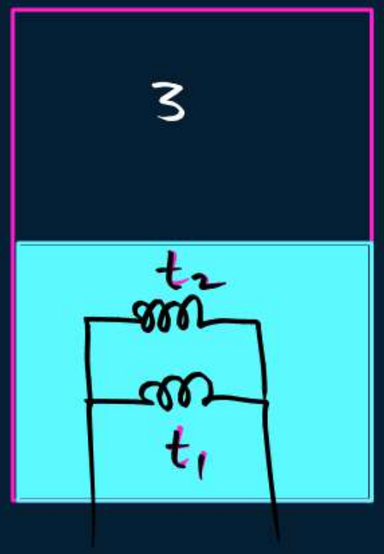
$$R_{net} = \frac{5R}{5+R}$$

Heater Coils in Series and Parallel





$$t = t_1 + t_2$$



$$t_{net} = \frac{t_1 t_2}{t_1 + t_2}$$

$$\frac{1}{t_{net}} = \frac{1}{t_1} + \frac{1}{t_2}$$

QUESTION

An electric kettle has two heating coils. When one of the coils is connected to an AC source, the water in the kettle boils in 10 min. When the other coil is used the water boils in 40 min. If both the coils are connected in "parallel", the time taken by the same quantity of water to boil will be

[CBSE AIPMT 2003]

(A) 25 min

(B) 15 min

(C) 8 min

(D) 4 min

$t_1 = 10$ min

$t_2 = 40$ min

$\rightarrow$ 50 min X

$$t = \frac{t_1 t_2}{t_1 + t_2}$$

$$= \frac{10 \times 40}{10 + 40} = \frac{400}{50} = 8$$

(Trade unit)

Commercial Unit of Energy

J - SI

ergs - CGS

Calorie - Practical

e-Volt — Use in 12th

Kilowatt-hour

(kWh)

1 unit = $\boxed{1\ kWh = 3.6 \times 10^6\ J}$

$1\ kW \times 1\ h$

$1000\ Watt \times 1\ hour$

Homework

- Derivation
  - Parallel mein cells ki
    $$\boxed{\varepsilon_{net} = \frac{\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} + \frac{\varepsilon_3}{r_3} \cdots}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} \cdots}}$$
  - Wheat stone bridge
- Practice Questions
- New chapter -4

PARISHRAM

2026

Lecture - 08

Current Electricity

PHYSICS **LECTURE - 8**

BY - RAKSHAK SIR

Topics *to be covered*

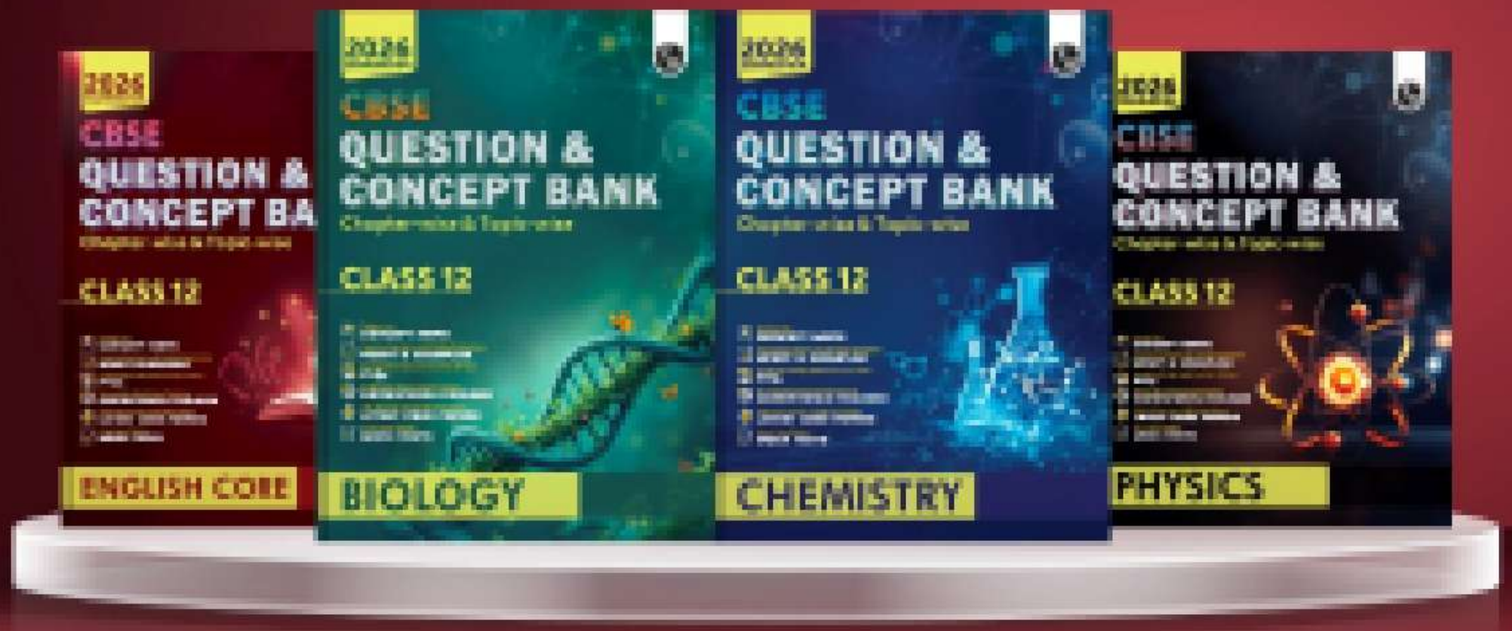
A Derivations
- Wheat-stone : Balance
- Cells in Parralled

B Practice Session

C

D

Boards Preparation Mein No Tension



- Chapter-wise & Topic-wise Weightage
- Competency-Based Revision
- Mock Tests As Per Latest Pattern
- NCERT & Exemplar Questions

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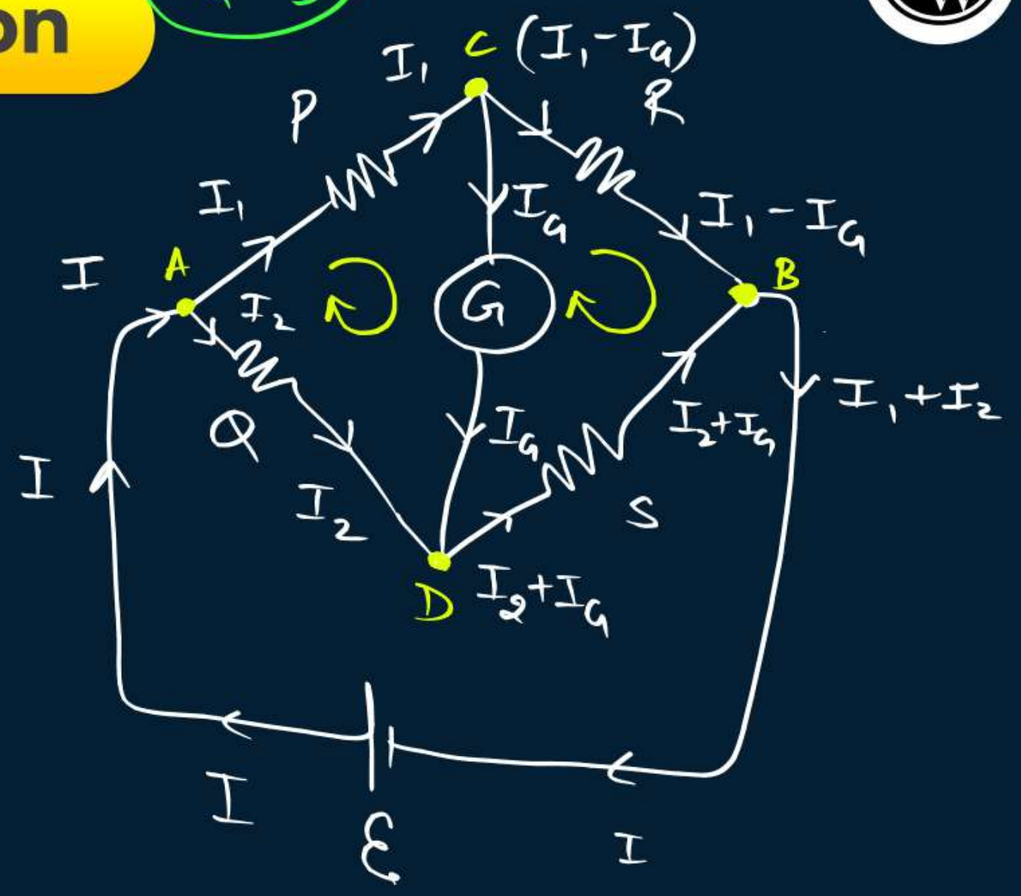
Wheatstone Bridge : Derivation

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



In loop CBDC, Apply K.V.L. :-

$$-(I_1 - I_G)R + (I_2 + I_G)S + I_G G = 0$$

In loop ACDA, Apply KVL :-

$$-I_1 P - I_G G + I_2 Q = 0$$

When $I_G = 0$, WSB considered balanced.

$$-I_1 R + I_2 S = 0 \Rightarrow I_2 S = I_1 R \quad \cdots (A)$$

$$-I_1 P + I_2 Q = 0 \Rightarrow I_2 Q = I_1 P \quad \cdots (B)$$

Divide (A) by (B) :-

$$\frac{\cancel{I_2} S}{\cancel{I_2} Q} = \frac{\cancel{I_1} R}{\cancel{I_1} P}$$

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

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

here we proved that it is the equation of Balanced W.S.B.

Electrons drift with speed v_d in a conductor with potential difference V across its ends. If V is reduced to $\left(\frac{V}{2}\right)$ their drift speed will become :

PYQ - 2024

$V_d = ?$

(A) $\frac{v_d}{2}$

(B) v_d

(C) $2v_d$

(D) $4v_d$

$V \rightarrow \frac{V}{2}$

$V_d \rightarrow \frac{V_d}{2}$

const.

$I = neAV_d$

$I \propto V_d$

By ohm's Law

$V \propto I$

$V \propto V_d$

The resistance of a wire is 10 Ω at 27 °C. Find its resistance at –73 °C. The temperature coefficient of resistance of the material of the wire is 1.70×10^{-4} °C^{-1}.

PYQ - 2024

M-II

Given :-

$\alpha = 1.7 \times 10^{-4}\ °C^{-1}$

$R_t = 10\Omega$, $27°C = T_1$

$R_{t'} = ?$, $-73°C = T_2$

$R_t = R_0 (1 + \alpha(\Delta T))$

$$\frac{10}{R'} = \frac{\cancel{R_0}(1 + 1.7 \times 10^{-4}(27))}{\cancel{R_0}(1 + 1.7 \times 10^{-4}(-73))}$$

$R_2 = R_1 (1 + \alpha(\Delta T))$

$R' = 10(1 + 1.7 \times 10^{-4}(-73-27))$

$R' = 10(1 + 1.7 \times 10^{-4}(-100))$

$= 10 + \frac{17}{100\cancel{00}}(-1\cancel{00})$

$= 10 - 0.17$

$R' = 9.83\ \Omega$

QUESTION

Two different wires X and Y of same diameter but different materials are joined in series across a battery. If the number density of electrons in X is twice that in Y, find the ratio of drift velocity of electrons in the two wires (PYQ-2023)

$$\boxed{n_x = 2n_y}$$

$$\frac{V_{d_x}}{V_{d_y}} = \frac{\frac{I}{n_x e \pi d^2/4}}{\frac{I}{n_y e \pi d^2/4}} = \frac{n_y}{n_x}$$

$$= \frac{n_y}{2n_y} = \frac{1}{2}$$

1:2 Ans

$$I = neAV_d$$

I is same in series

$$V_d = \frac{I}{neA}$$ const.

$$V_d = \frac{I}{ne\frac{\pi d^2}{4}}$$

$$A = \pi r^2$$

$$r = \frac{d}{2}$$

$$A = \frac{\pi d^2}{4}$$

QUESTION

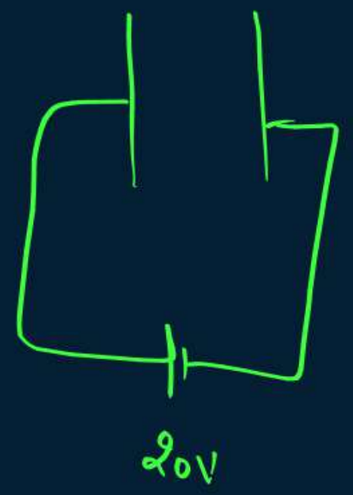
Find potential difference between X and Y

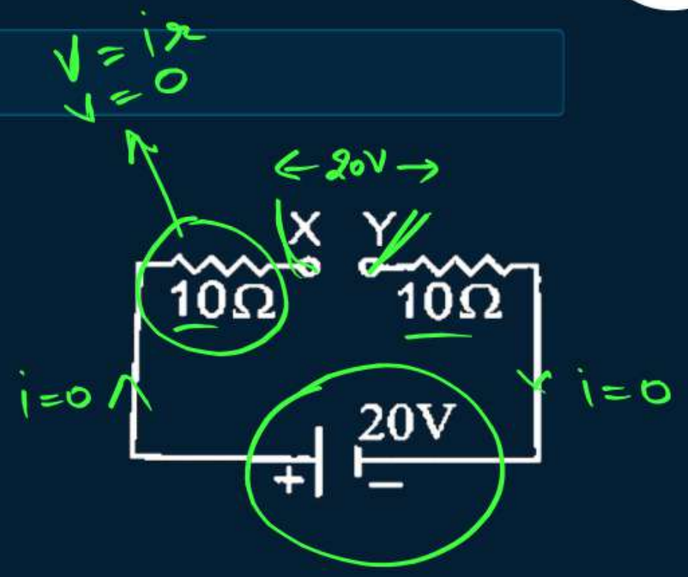
A 10

B 20

C 0

D 5





QUESTION

M.P.T.

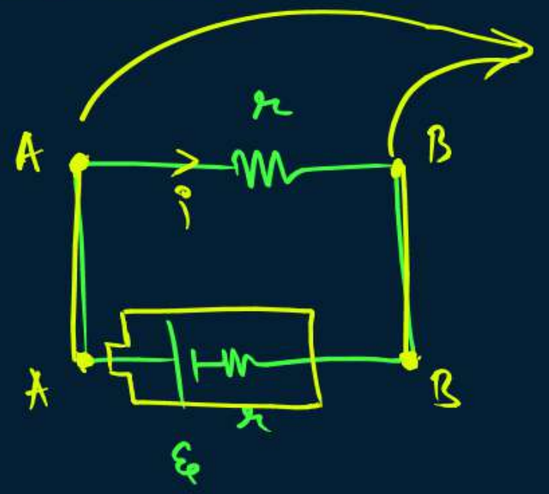
The e.m.f. of a cell is E volts and internal resistance is *r* ohm. The resistance in external circuit is also *r* ohm. The p.d. across the cell will be

(A) E/2

(B) 2E

(C) 4E

(D) E/4



$V_{AB} = ir$

$= \frac{\varepsilon}{2r} \times r$

$= \frac{\varepsilon}{2}$

$i = \frac{V_T}{R_T}$

$= \frac{\varepsilon}{r+r} = \frac{\varepsilon}{2r}$

QUESTION

The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is **[NEET 2013]**

(A) 0.2 Ω

(B) 0.5 Ω

(C) 0.8 Ω

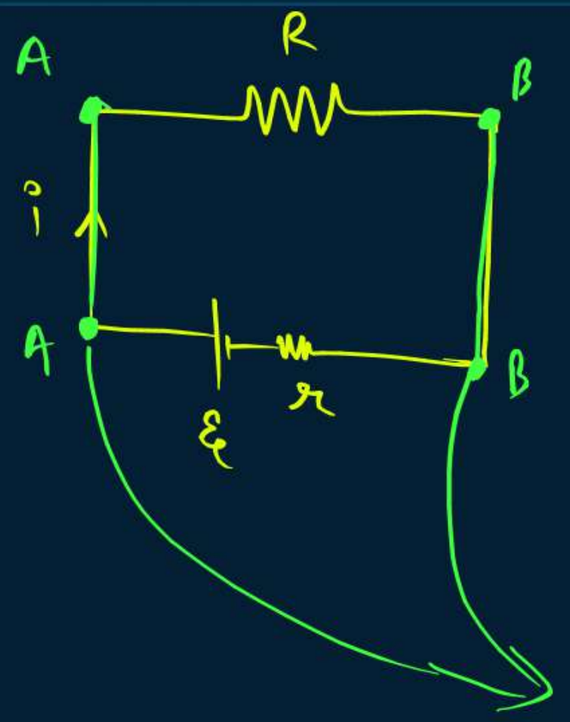
(D) 1.0 Ω

$r = ?$

$\mathcal{E} = 2.1\ V$

$i = 0.2\ A$

$R = 10\ \Omega$



$V_{AB} = iR = 0.2 \times 10 = 2V$

$V_{AB} = \mathcal{E} - ir$

$2 = 2.1 - 0.2r$

QUESTION

The potential difference between the terminals of a cell in an open circuit is 2.2 V. When a resistor of 5Ω is connected across the terminals of the cell, the potential difference between the terminals of the cell is found to be 1.8 V. The internal resistance of the cell is **[2002]**

$i = 0$ $\quad$ $\mathcal{E}$

(A) $\frac{7}{12}\Omega$

(B) $\frac{10}{9}\Omega$

(C) $\frac{9}{10}\Omega$

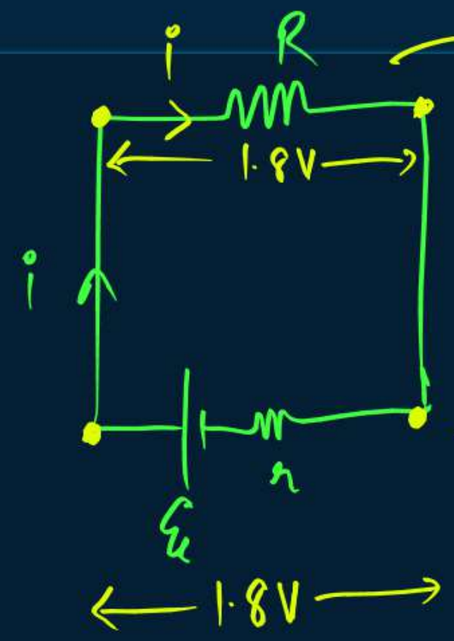
(D) $\frac{12}{7}\Omega$

$\mathcal{E} = 2.2\,V$

$R = 5\Omega$

$V = 1.8\,V$

$r = ?$



$i = \frac{V}{R} = \frac{1.8}{5}\,A$

$V = \mathcal{E} - ir$

$1.8 = 2.2 - \frac{1.8}{5} r$

QUESTION

$V = \mathcal{E} - ir$

A student measures the terminal potential difference (V) of a cell (of emf E and internal resistance *r*) as a function of the current (I) flowing through it. The slope and intercept, of the graph between V and I, then, respectively, equal: [2009]

(A) –*r* and *E*

(B) *r* and –*E*

(C) –*E* and *r*

(D) *E* and –*r*

$y = mx + c$

$V = -ri + \mathcal{E}$

$m = -r$

$c = +\mathcal{E}$

QUESTION

A primary cell has an e.m.f. of 1.5 volts, when short-circuited it gives a current of 3 amperes. The internal resistance of the cell is

(A) 4.5

(B) 2

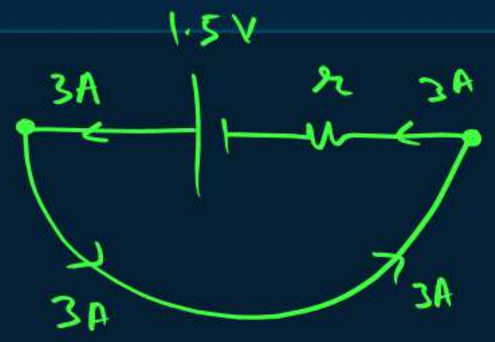
(C) 0.5 ✓

(D) 1/4.5

$\mathcal{E} = 1.5\,V$

$i = 3A$

$r = ?$



$V = ir$

$1.5 = 3 \times r$

$r = \frac{1.5}{3}$

$r = \frac{1}{2} = 0.5\,\Omega$

QUESTION

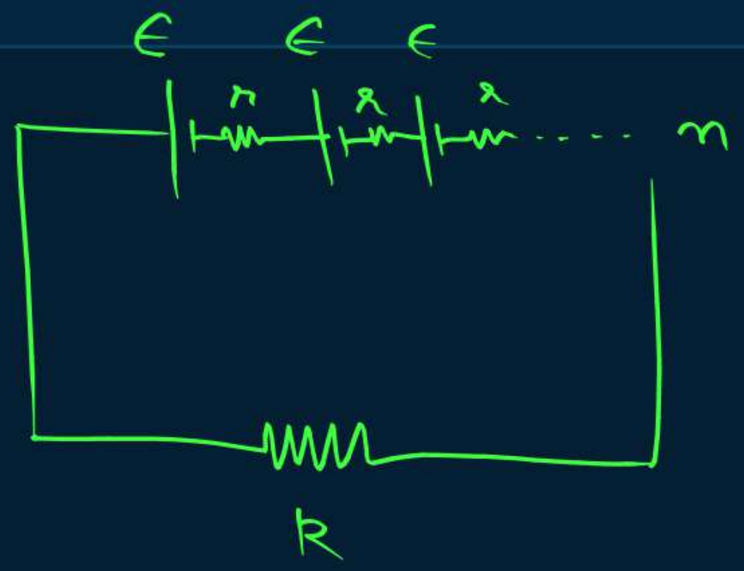
n identical cells each of e.m.f. E and internal resistance r are connected in series. An external resistance R is connected in series to this combination. The current through R is

(A) $\frac{nE}{R+nr}$

(B) $\frac{nE}{nR+r}$

(C) $\frac{E}{R+nr}$

(D) $\frac{nE}{R+r}$



$$i = \frac{V_{total}}{R_{total}}$$

$$i = \frac{n\varepsilon}{R+nr}$$

QUESTION

There are n cells of emf E each and internal resistance r each. Out of these n cells, m are wrongly (oppositely) joined Find Eeq. and req? [HCV]

(A) $(n - m)E, nr$

(B) $(n - 2m)E, nr$

(C) nE, nr

(D) $(n - m)E, mr$

$n - 2m$

QUESTION

Total no. of cells = 100. Each internal resistance = 1Ω. External resistance = 25 Ω. Find value of n and m for which current in external resistor is maximum.

$r = 1\Omega$ R

PYQ

M.P.T. Theorem

(A) 25, 4

(B) 4, 25

(C) 50, 2

(D) 2, 50

$n \rightarrow$ cells in one row

$m \rightarrow$ no. of rows

$r_{net} = \frac{nr}{m}$

Total Internal R = Ext. R

$\frac{nr}{m} = R$

$\frac{n}{m} \times 1 = 25$

$\frac{n}{m} = 25$

$n = 25m$

$n \times m = 100 \quad \cdots (1)$

$25m^2 = 100$

$m^2 = \frac{\cancel{100}\,4}{\cancel{25}}$

$m^2 = 4$

$\boxed{m = 2}$ $\boxed{n = 50}$

QUESTION

P V R = ?

A bulb has rated values as 100W, 220V. The resistance of the bulb is

A. 100 Ω

B. 220 Ω

C. 121 Ω

D. 484 Ω

$$P = \frac{V^2}{R}$$

$$100 = \frac{220 \times 220}{R}$$

$$R = \frac{22\cancel{0} \times 22\cancel{0}}{1\cancel{00}}$$

$$= 484\,\Omega$$

QUESTION

The total power dissipated in watts in the circuit shown here is [2007]

A 40

B 64

C 4

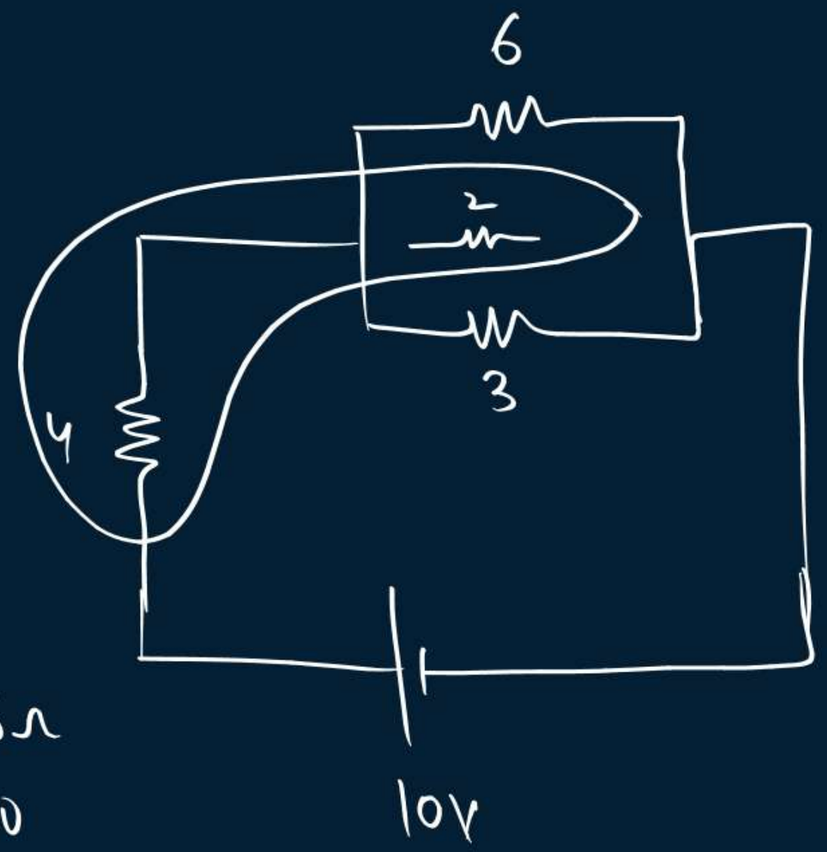
D 16

$P = \frac{V^2}{R}$

$= \frac{(10)^2}{6}$

$= \frac{100}{6}$

$P = 16.66$

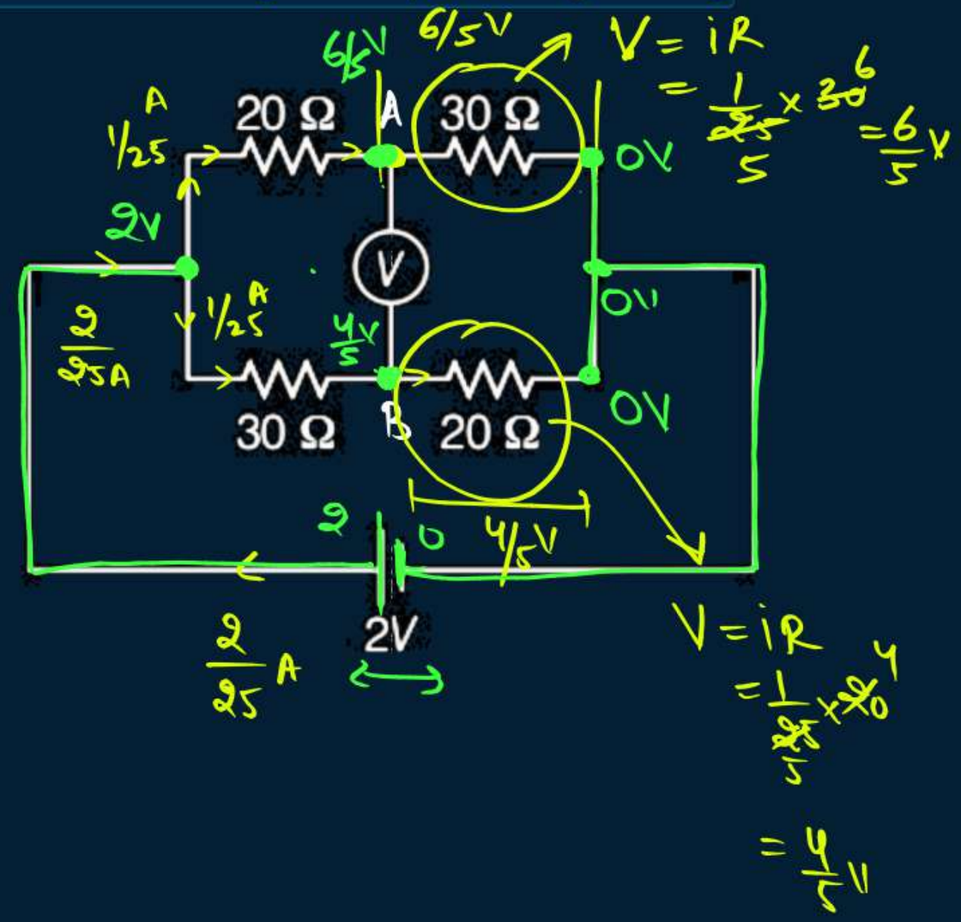


$R_t = 6\Omega$

$V = 10$

QUESTION

The reading of an ideal voltmeter in the circuit shown in [NEET (Odisha) 2019]

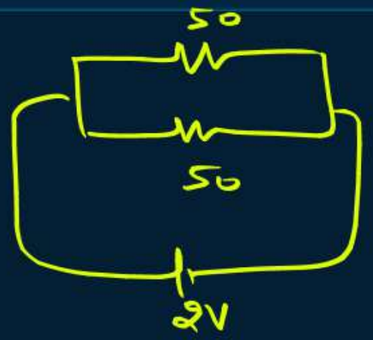


(A) 0.6 V

(B) 0 V

(C) 0.5 V

(D) 0.4 V



$V = iR$

$2 = i \times 25$

$i = \frac{2}{25} A$

$A \rightarrow \frac{6}{5} V$

$B \rightarrow \frac{4}{5} V$

$\Delta V = \frac{6}{5} - \frac{4}{5}$

$= \frac{2}{5} = 0.4 V$

Infinite Ladder Problem

Quadratic eq^n solve

$$R = \frac{R}{R+1} + 1$$

$$R = \frac{R + 1(R+1)}{R+1}$$

$$R = \frac{R+R+1}{R+1}$$

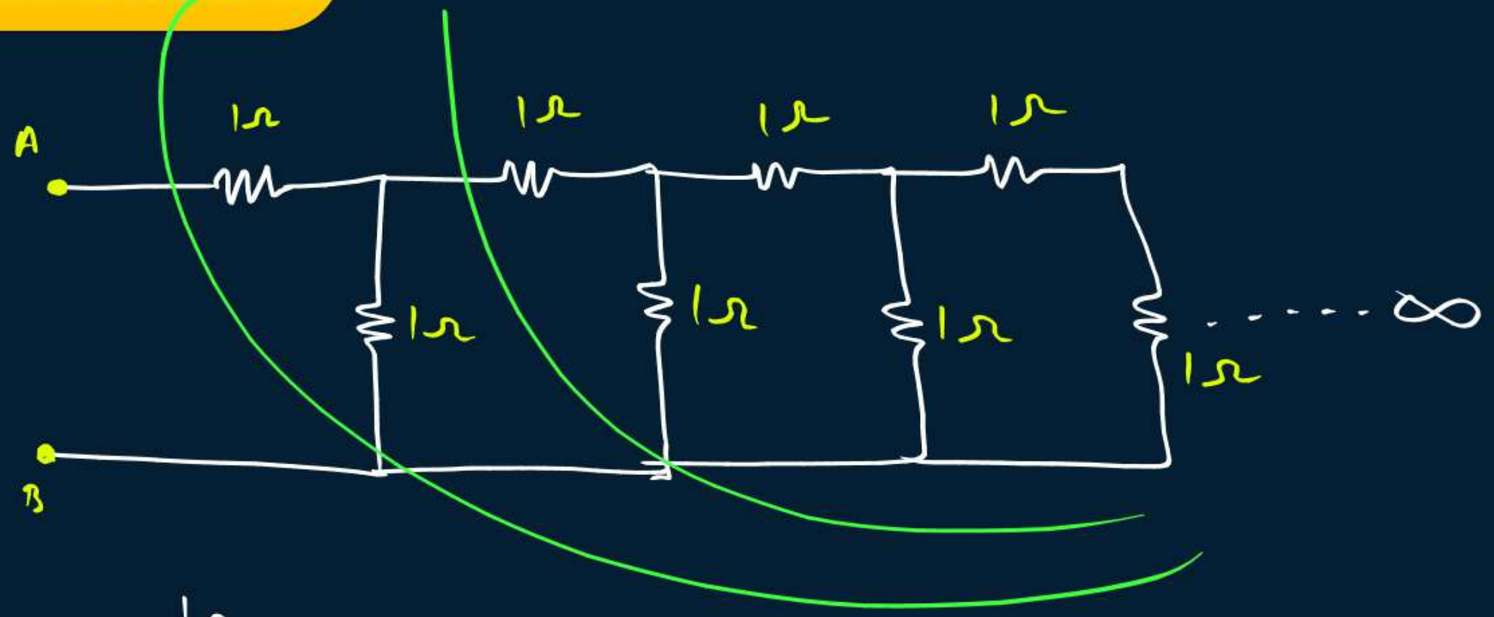
$$R^2 + R = 2R + 1$$

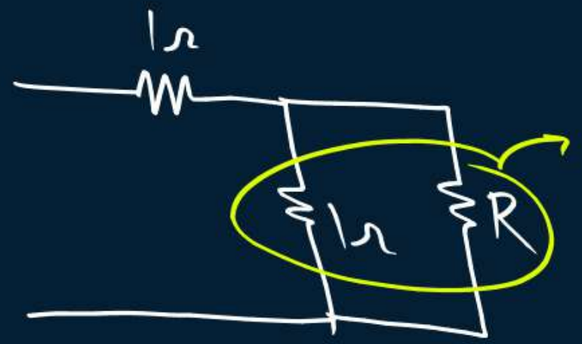
$$R^2 - 2R - 1 + R = 0$$

$$\boxed{R^2 - R - 1 = 0}$$

Solve using 'D' method

Reject -ve, Accept +ve ✓





$$\frac{R \times 1}{R+1} = \frac{R}{R+1}$$

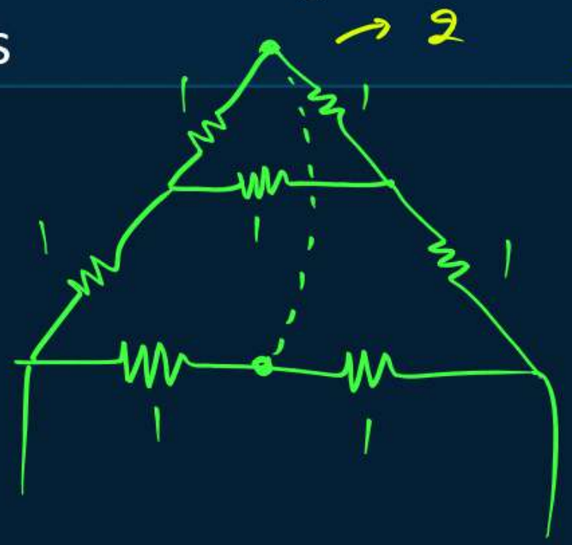
$$R_{total} = \frac{R}{R+1} + 1$$

$$\boxed{R = \frac{R}{R+1} + 1}$$

QUESTION

J.R.M. → Junction removal M.

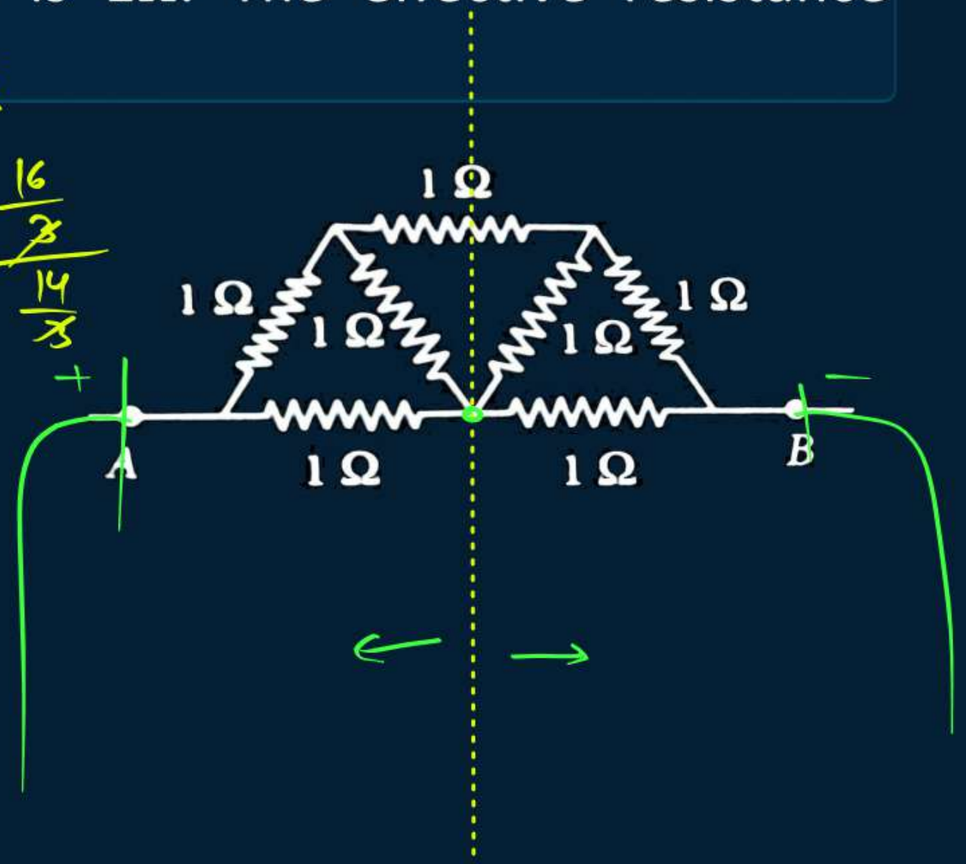
In the network shown in figure each resistance is 1Ω. The effective resistance between A and B is



$\frac{2}{3} + 2 = \frac{8}{3}$

$\frac{\frac{8}{3} \times 2}{\frac{8}{3} + 2} = \frac{\frac{16}{3}}{\frac{14}{3}}$

$\frac{16}{14} = \frac{8}{7}$



(A) 4/3 Ω

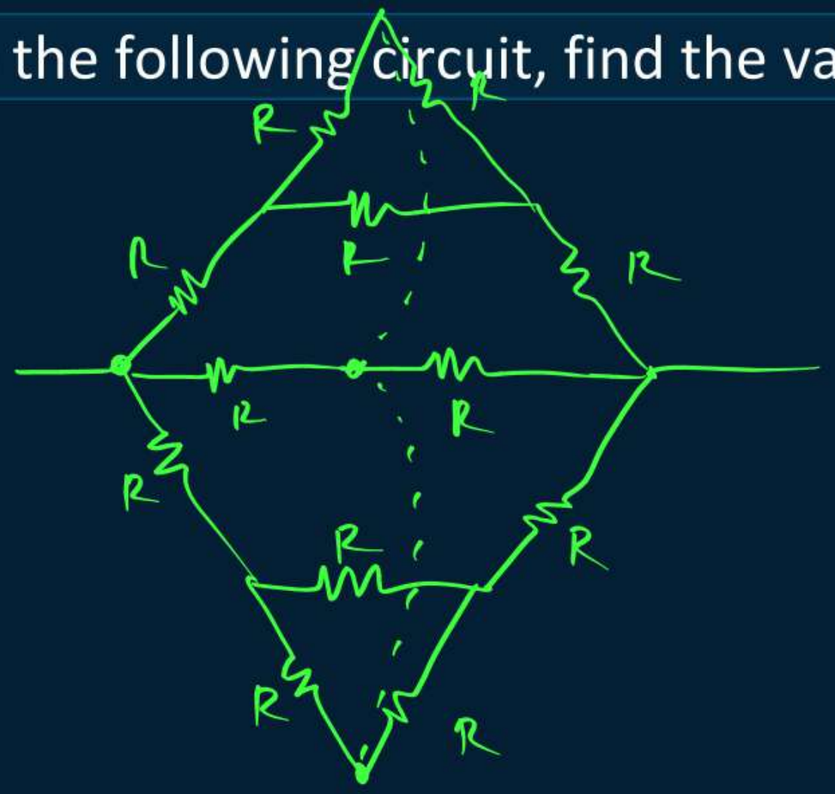
(B) 3/2 Ω

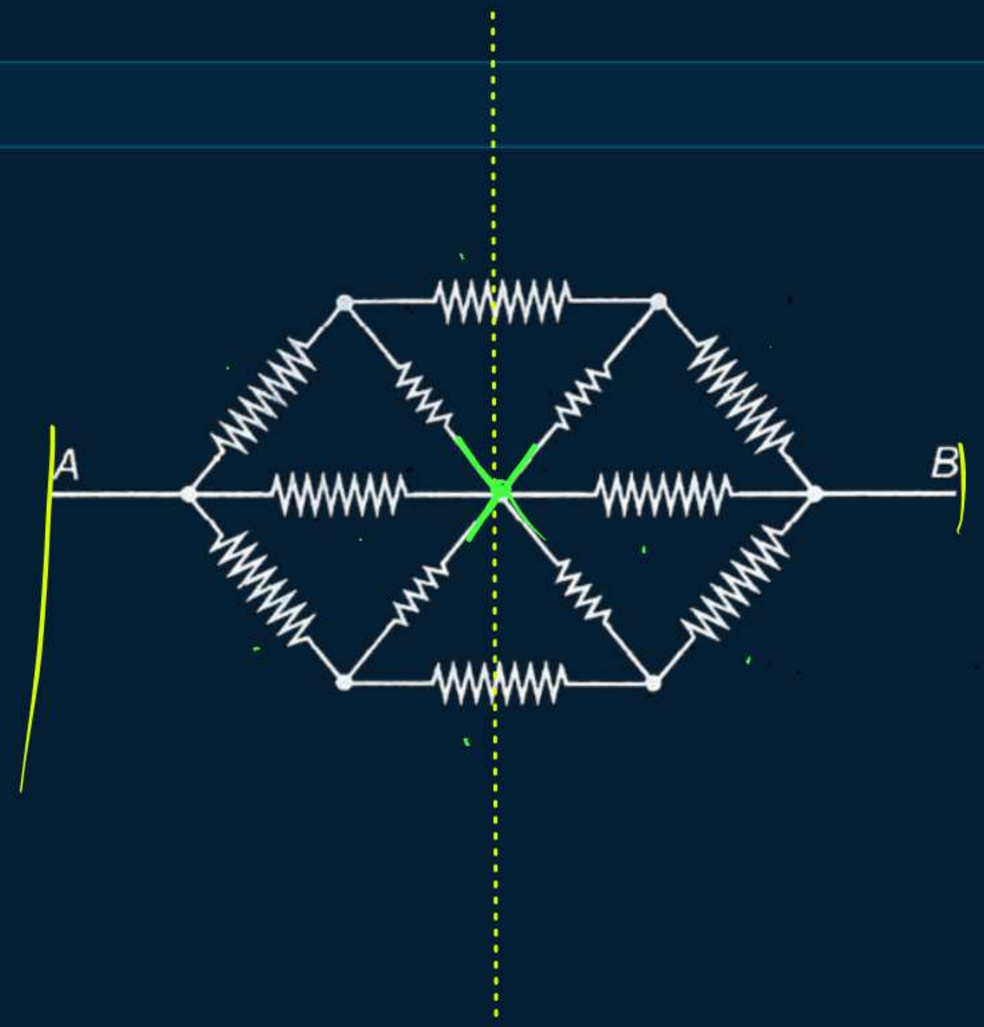
(C) 7 Ω

(D) 8/7 Ω

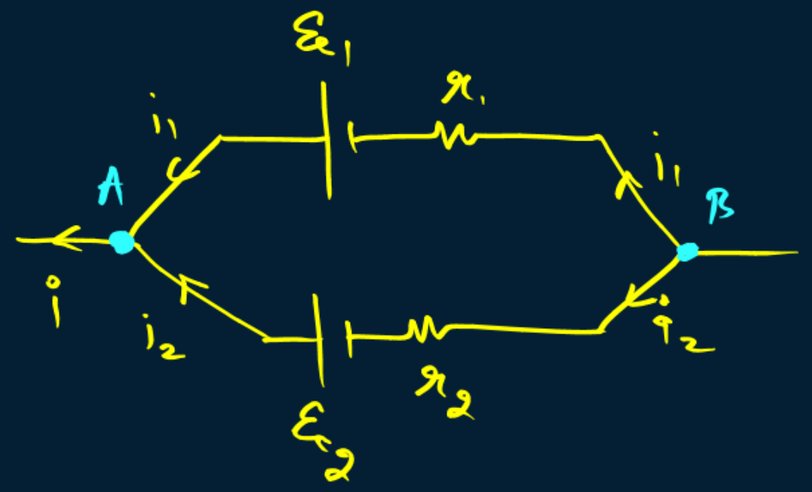
QUESTION

In the following circuit, find the value of R_{AB}.

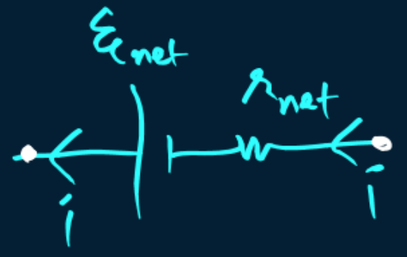




$$\mathcal{E}_{net} = \frac{\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2} + \cdots}{\frac{1}{r_1} + \frac{1}{r_2} + \cdots}$$



$\equiv$



$$V = \mathcal{E}_{net} - i\, r_{net}$$

At A, Applying KCL:-

$$i = i_1 + i_2$$

$$i = \frac{\mathcal{E}_1 - V}{r_1} + \frac{\mathcal{E}_2 - V}{r_2}$$

$$i = \frac{\mathcal{E}_1}{r_1} - \frac{V}{r_1} + \frac{\mathcal{E}_2}{r_2} - \frac{V}{r_2}$$

$$i = \frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2} - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$V_{AB} = \mathcal{E}_1 - i_1 r_1 \quad \cdots (I)$$

$$i_1 r_1 = \mathcal{E}_1 - V$$

$$i_1 = \frac{\mathcal{E}_1 - V}{r_1}$$

$$V_{AB} = \mathcal{E}_2 - i_2 r_2 \quad \cdots (II)$$

$$\vdots$$

$$i_2 = \frac{\mathcal{E}_2 - V}{r_2}$$

$$i = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$V\left(\frac{1}{r_1} + \frac{1}{r_2}\right) = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} - i$$

$$V\left(\frac{r_1 + r_2}{r_1 r_2}\right) = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 r_2} - i$$

$$V = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{\cancel{r_1 r_2}} \times \frac{\cancel{r_1 r_2}}{r_1 + r_2} - \frac{i\, r_1 r_2}{r_1 + r_2}$$

$$V = \left(\frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}\right) - i\left(\frac{r_1 r_2}{r_1 + r_2}\right)$$

$$V = \varepsilon_{net} - i\, r_{net}$$

$$\varepsilon_{net} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}, \quad r_{net} = \frac{r_1 r_2}{r_1 + r_2}$$

dividing by "$r_1 r_2$"

Upar Neeche

$$\varepsilon_{net} = \frac{\dfrac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 r_2}}{\dfrac{r_1 + r_2}{r_1 r_2}}$$

$$\varepsilon_{net} = \frac{\dfrac{\varepsilon_1 \cancel{r_2}}{r_1 \cancel{r_2}} + \dfrac{\varepsilon_2 \cancel{r_1}}{\cancel{r_1} r_2}}{\dfrac{\cancel{r_1}}{\cancel{r_1} r_2} + \dfrac{\cancel{r_2}}{r_1 \cancel{r_2}}} = \frac{\dfrac{\varepsilon_1}{r_1} + \dfrac{\varepsilon_2}{r_2}}{\dfrac{1}{r_1} + \dfrac{1}{r_2}}$$

$$\boxed{\mathcal{E}_{net} = \frac{\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}}$$

$$\mathcal{E}_{net} = \frac{\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2}}{\frac{1}{r_{net}}}$$

$$\boxed{\frac{\mathcal{E}_{net}}{r_{net}} = \frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2} + \frac{\mathcal{E}_3}{r_3} \cdots\cdots}$$

Homework

- Notes
- 12 Baje Recorded Dekhna → 15min
- Assignment –
- NCERT Punch
  - summary lec
  - NCERT Ques