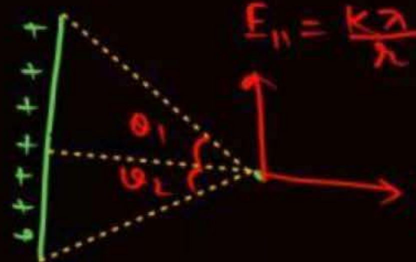
TOPICS *to be covered*

1. Electrostatics
2. current Electricity
3. capacitor
4. magnetism
5. EMI/AC
6. modern Physics
7. semi conductor
8. EMW
9. optics
10. wave optics.

* Theory & imp formula (Revision short cut)
* 2023 JEE mains PYQ
* 2020-2022 PYQ + Extra imp Ques
  Sheet/module imp ques.
  + JA Ques imp

Electrostatics

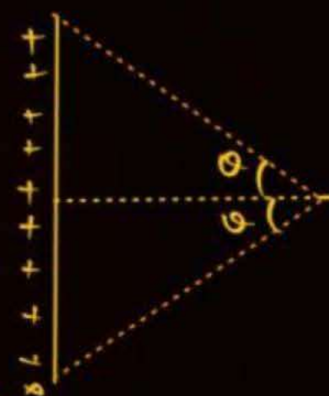
q $\longleftarrow r \longrightarrow$ $E = \frac{Kq}{r^2}$



$E_{\parallel} = \frac{K\lambda}{r}(\cos\theta_1 - \cos\theta_2)$

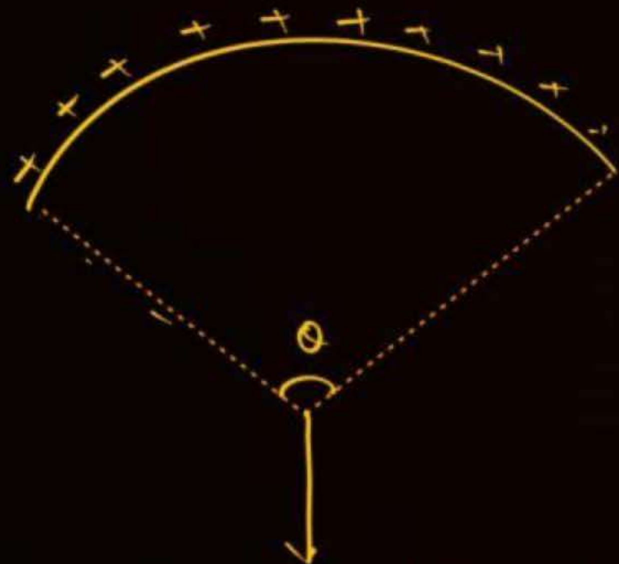
$E_{\perp} = \frac{K\lambda}{r}(\sin\theta_1 + \sin\theta_2)$

If $\theta_1 = \theta_2 = \theta$



$\longrightarrow E = \frac{2K\lambda}{r}\sin\theta$

$$\boxed{\begin{array}{c}\underline{\infty \text{ wire}} \Rightarrow \theta_1 = \theta_2 = 90^\circ \\ E = \frac{2K\lambda}{r}\end{array}}$$

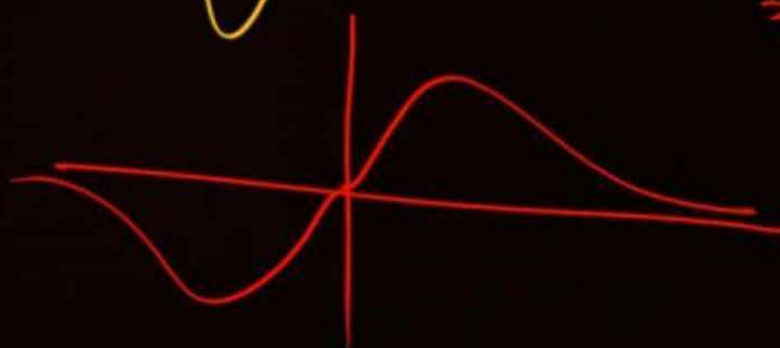


$$E = \frac{2k\lambda}{r}\sin\theta/2$$

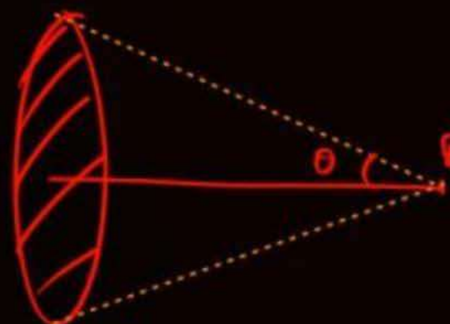
Rim (+Q, R)

$$E = \frac{KQx}{(R^2+x^2)^{3/2}}$$

$$x = \pm\frac{R}{\sqrt{2}} \quad E_{max}$$



Disc



$E = \frac{\sigma}{2\epsilon_0}(1-\cos\theta)$

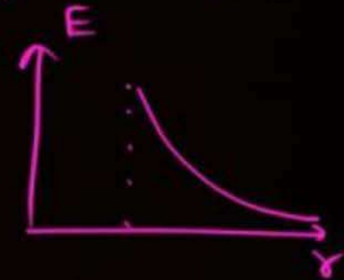
∞ Disc $\Rightarrow$ $\theta \to 90^\circ$ $\quad E = \frac{\sigma}{2\epsilon_0}$

Shell
hollow sphere (Q, R) // conducting sphere

$E = 0 \quad r<R$

$E = \frac{KQ}{r^2} \quad r>R$

$E = \frac{KQ}{R^2} \quad r=R$

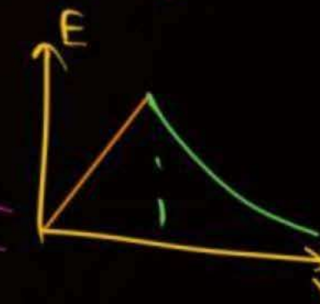


Solid Non conducting sphere

$r<R \Rightarrow E = \frac{KQr}{R^3} = \frac{\rho r}{3\epsilon_0}$

$r=R \Rightarrow E = \frac{KQ}{R^2}$

$r>R \Rightarrow E = \frac{KQ}{r^2}$



$$\phi \boxed{= \oint \vec{E} \cdot d\vec{s} = \frac{q_{in}}{\epsilon_0}}$$

$$\phi = \frac{q_{in}}{\epsilon_0}$$

Common Qun.

$$\rho = \rho_0 r$$

(1) total charge

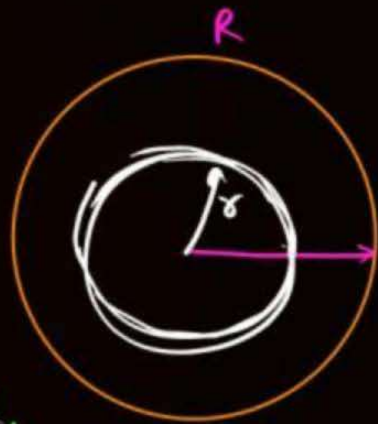
$$dq = \rho dV$$

$$\int dq = \int_0^R \rho_0 r \, 4\pi r^2 dr$$

$$= Q_{total} = Q_0$$

(2) $r > R$ outside

$$E \cdot 4\pi r^2 = \frac{Q}{\epsilon_0} = \frac{\int_0^R \rho 4\pi r^2 dr}{\epsilon_0}$$



inside $r < R$

$$E \cdot 4\pi r^2 = \frac{\int_0^r \rho 4\pi r^2 dr}{\epsilon_0}$$

dipole

$-q \xrightarrow{\vec{d}} +q$

$\longleftarrow d \longrightarrow$

$\vec{P} = q\vec{d}$

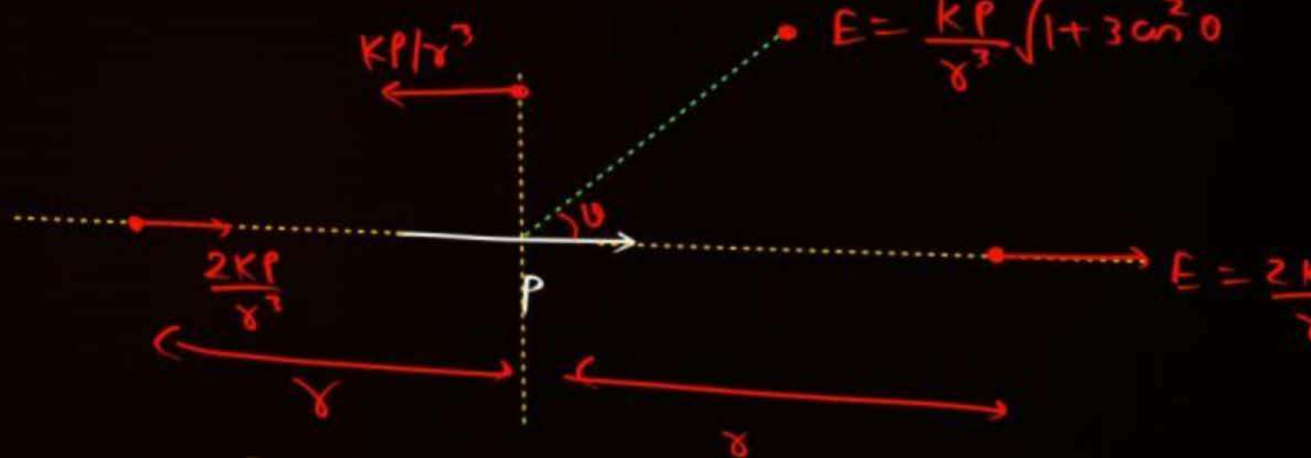
$\theta_1 \longrightarrow \theta_2$ rotate

$(WD)_{ext} = \Delta U = -PE(\cos\theta_2 - \cos\theta_1)$

$= PE(\cos\theta_1 - \cos\theta_2)$

Er

short dipole



$\vec{\tau} = \vec{P} \times \vec{E} \Rightarrow$

$$\boxed{T = 2\pi\sqrt{\frac{I}{PE}}}$$

$U = -\vec{P}\cdot\vec{E}$

Electric potential

q • —— r —— • $V = \frac{Kq}{r}$

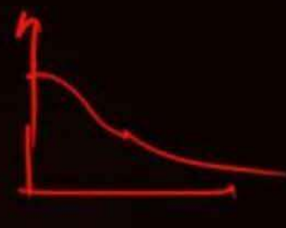
hollow sphere

$\to \frac{KQ}{R}$

$V_{in} = \frac{KQ}{R}$

• $\frac{KQ}{r}$

Solid sphere



O —— r —— A

$r > R$ outside

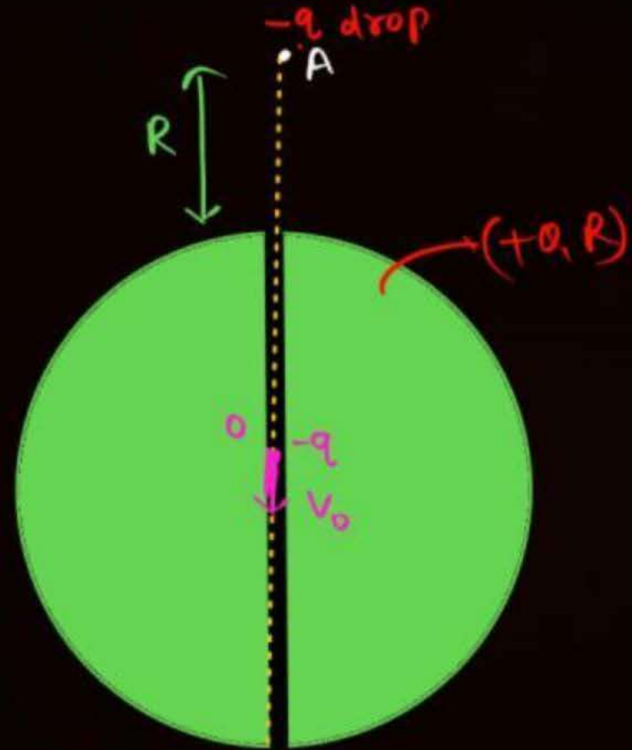
$V = \frac{KQ}{r}$

$V_{surface} = \frac{KQ}{R}$

$$V_A = V_{inside} = \frac{KQ}{2R^3}\left(3R^2 - r^2\right)$$

$$V_{at\ centre} = \frac{3KQ}{2R}$$

Q



$$K_i + U_i = K_f + U_f$$

$$0 + (-q)V_A = \frac{1}{2} m v_0^2 + (-q)V_0$$

$$-q\,\frac{KQ}{2R} = \frac{1}{2} m v_0^2 - q\,\frac{3}{2}\frac{KQ}{R}$$

$$\boxed{E = -\frac{\partial V}{\partial x}}$$

$$\vec{E_x} = -\left(\frac{\partial V}{\partial x}\right)_{y,z\ \text{const}} \hat{i}$$

$$dV = -\vec{E}\cdot d\vec{r}$$

$$\vec{E} = E_x\hat{i} + E_y\hat{j} + E_z\hat{k}$$

$$d\vec{r} = dx\,\hat{i} + dy\,\hat{j} + dz\,\hat{k}$$

$$\Delta V = \int dV = -\left[\int E_x\,dx + \int E_y\,dy + \int E_z\,dz\right]$$

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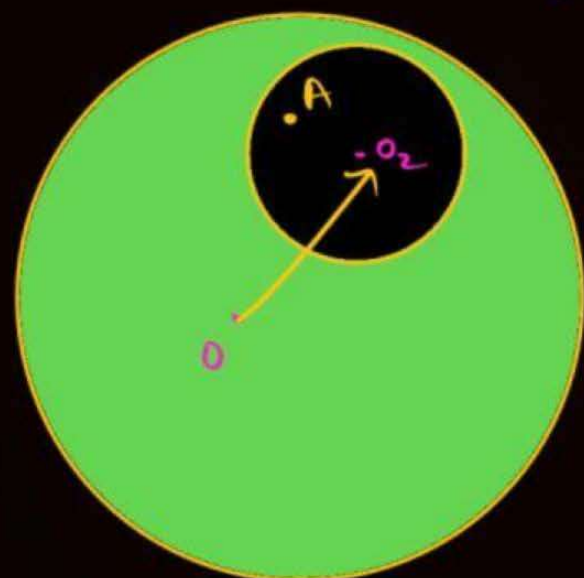
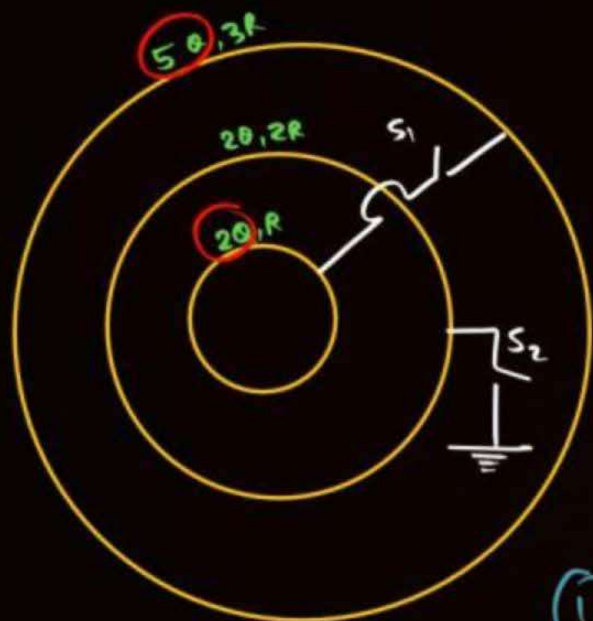
$$E_A = \frac{\rho\,\overrightarrow{O_1O_2}}{3\epsilon_0}$$

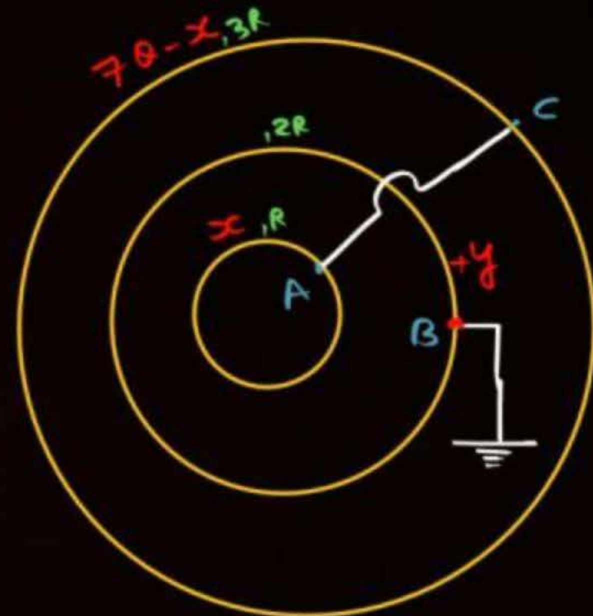
→ Uniform

→ $\neq 0$



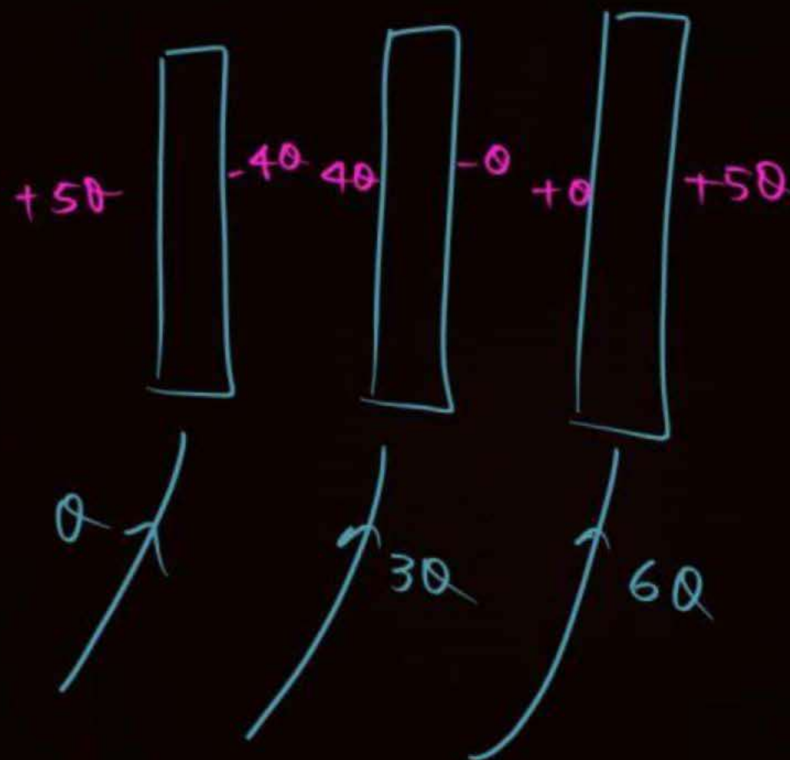
Q



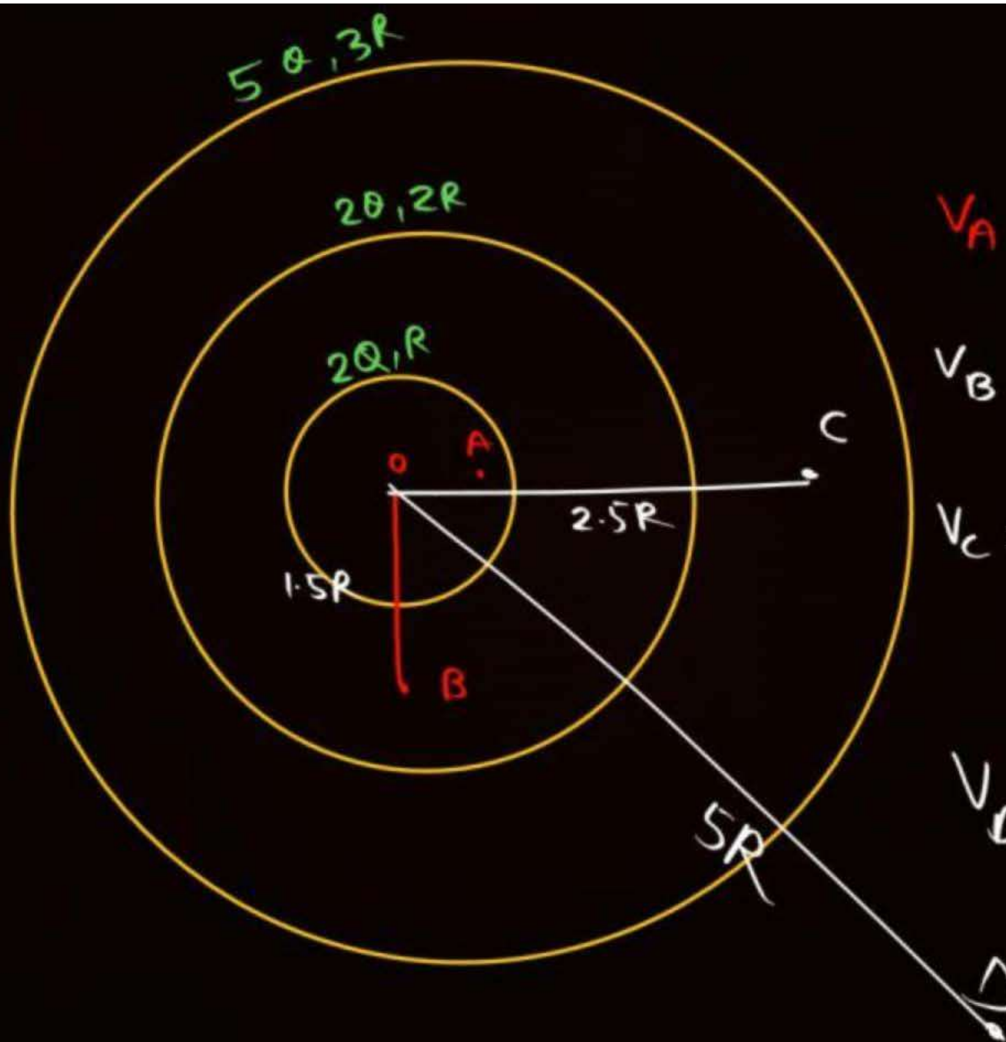


① $V_A = V_C$

② $V_B = 0 = \frac{kx}{2R} + \frac{ky}{2R} + \frac{k(7Q-x)}{3R}$


+5Q
-4Q
4Q
-Q
+Q
+5Q
Q
3Q
6Q

Q



$$V_A = \frac{K2Q}{R} + \frac{K2Q}{2R} + \frac{K5Q}{3R}$$

$$V_B = \frac{K2Q}{1.5R} + \frac{K2Q}{2R} + \frac{K5Q}{3R}$$

$$V_C = \frac{K2Q}{2.5R} + \frac{K2Q}{2.5R} + \frac{K5Q}{3R}$$

$$V_D = \frac{K9Q}{5R}$$

$$\vec{F} = q\vec{E}$$

$$U = qV$$

QUESTION

Must try

Two electrons each are fixed at a distance '2d'. A third charge proton placed at the midpoint is displaced slightly by a distance x (x << d) perpendicular to the line joining the two fixed charges. Proton will execute simple harmonic motion having angular frequency : (m = mass of charged particle) **[JEE Mains 2021]**

(1) $\left(\dfrac{2q^2}{\pi\varepsilon_0 m d^3}\right)^{\frac{1}{2}}$

(2) $\left(\dfrac{\pi\varepsilon_0 m d^3}{2q^2}\right)^{\frac{1}{2}}$

(3) $\left(\dfrac{q^2}{2\pi\varepsilon_0 m d^3}\right)^{\frac{1}{2}}$

(4) $\left(\dfrac{2\pi\varepsilon_0 m d^3}{q^2}\right)^{\frac{1}{2}}$

Ans. (3)

QUESTION

512 identical drops of mercury are charged to a potential of 2V each. The drops are joined to form a single drop. The potential of this drop is ____ V. **[JEE Mains 2021]**

Easy

Ans. 128

QUESTION

Two small spheres each of mass 10 mg are suspended from a point by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.20 m. The charge on each of the sphere is $\frac{a}{21} \times 10^{-8}$C. The value of 'a' will be ____.

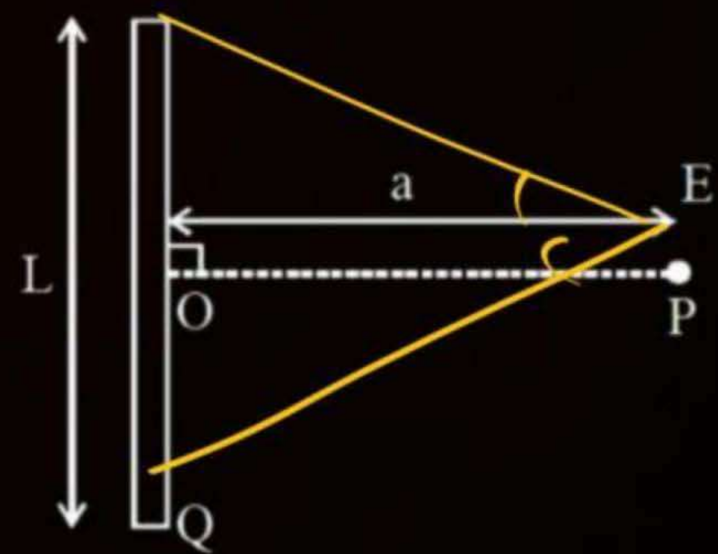
[Given $g = 10$ ms^{-2}] **[JEE Mains 2021]**

Ans. 20

QUESTION

Find the electric field at point P (as shown in figure) on the perpendicular bisector of a uniformly charged thin wire of length L carrying a charge Q. The distance of the point P from the centre of the rod is $a = \frac{\sqrt{3}}{2}L$.

[JEE Mains 2021]



(1) $\dfrac{\sqrt{3}Q}{4\pi\varepsilon_0 L^2}$

(2) $\dfrac{Q}{3\pi\varepsilon_0 L^2}$

(3) $\dfrac{Q}{2\sqrt{3}\pi\varepsilon_0 L^2}$

(4) $\dfrac{Q}{4\pi\varepsilon_0 L^2}$

Ans. (3)

QUESTION

A certain charge Q is divided into two parts q and (Q – q). How should the charges Q and q be divided so that q and (Q – q) placed at a certain distance apart experience maximum electrostatic repulsion?

[JEE Mains 2021]

1. $\frac{q}{2}$
2. $Q = 2q$
3. $Q = 4q$
4. $Q = 3q$

Ans. (2)

QUESTION

$\frac{q}{m} =$

$\sqrt{\frac{8 \times .1 \times}{\frac{8\times 10^{-6}}{10^{-3}} \times 100}} = \sqrt{\frac{10^{3} \times .1}{1000}} = 1$

A body having specific charge 8 μC/g is resting on a frictionless plane at a distance 10 cm from the wall (as shown in the figure). It starts moving towards the wall when a uniform electric field of 100 V/m is applied horizontally towards the wall. If the collision of the body with the wall is perfectly elastic, then the time period of the motion will be _____ s.

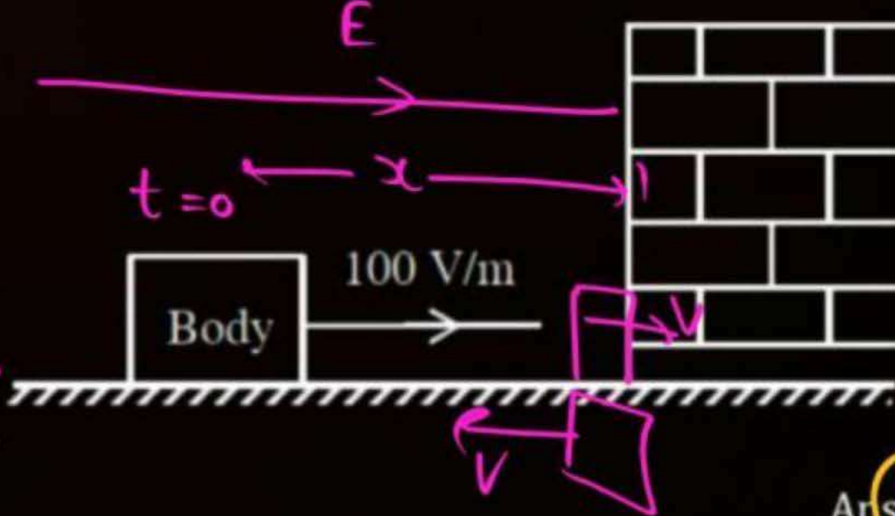
[JEE Mains 2021]

$$x = 0 + \frac{1}{2} a t^2$$

$$x = \frac{1}{2} \times \frac{qE}{m} t^2$$

$$t = \sqrt{\frac{2xm}{qE}}$$

Ans $2t = \sqrt{\frac{8xm}{qE}}$



Ans. 1

QUESTION

Class note

Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a fixed point by threads of length 'l'. What is the equilibrium separation when each thread makes a small angle 'θ' with the vertical ?

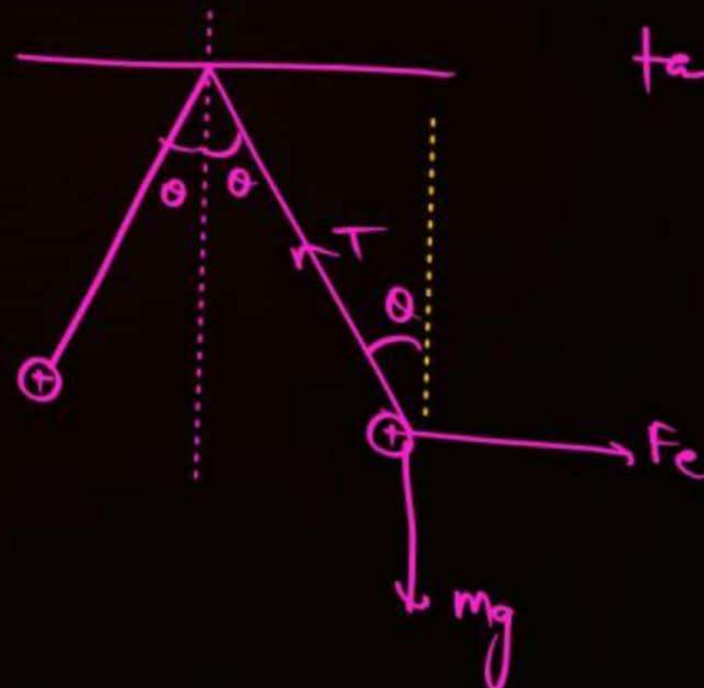
[JEE Mains 2021]

(1) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{2}}$

(2) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

(3) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{\frac{1}{3}}$

(4) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{\frac{1}{3}}$



$\tan\theta = \frac{F_e}{mg}$

Ans. (2)

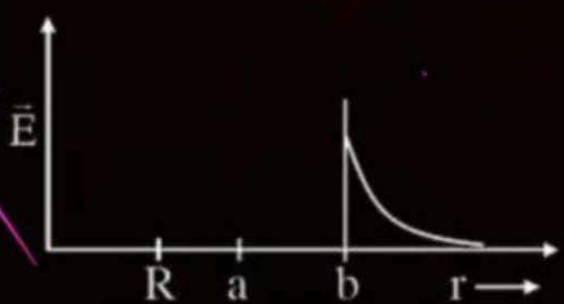
QUESTION

HW

A solid metal sphere of radius R having charge q is enclosed inside the concentric spherical shell of inner radius a and outer radius b as shown in figure. The approximate variation electric field $\vec{E}$ as a function of distance r from centre O is given by : **[JEE Mains 2021]**

(1)


(2)


(3)


(4)


Ans. (1)

QUESTION

for

A uniformly charged disc of radius R having surface charge density σ is placed in the xy plane with its center at the origin. Find the electric field intensity along the z-axis at a distance Z from origin :-

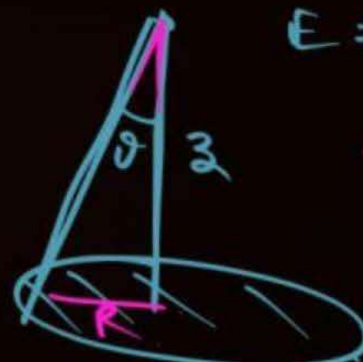
[JEE Mains 2021]

(1) $E=\dfrac{\sigma}{2\varepsilon_0}\left(1-\dfrac{Z}{(Z^2+R^2)^{1/2}}\right)$

(2) $E=\dfrac{\sigma}{2\varepsilon_0}\left(1+\dfrac{Z}{(Z^2+R^2)^{1/2}}\right)$

(3) $E=\dfrac{2\varepsilon_0}{\sigma}\left(\dfrac{1}{(Z^2+R^2)^{1/2}}+Z\right)$

(4) $E=\dfrac{\sigma}{2\varepsilon_0}\left(\dfrac{1}{(Z^2+R^2)}+\dfrac{1}{Z^2}\right)$



$$E=\frac{\sigma}{2\varepsilon_0}(1-\cos\theta)$$

$$=\frac{\sigma}{2\varepsilon_0}\left(1-\frac{z}{\sqrt{z^2+R^2}}\right)$$

Ans. (1)

QUESTION

for formula

Figure shows a rod AB, which is bent in a 120° circular arc of radius R. A charge (–Q) is uniformly distributed over rod AB. What is the electric field $\vec{E}$ at the centre of curvature O ?

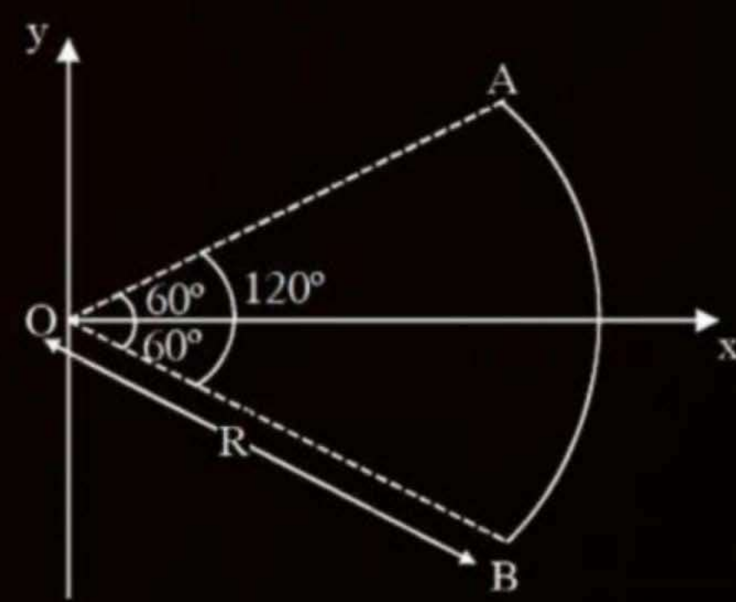
[JEE Mains 2021]

(1) $\frac{3\sqrt{3}Q}{8\pi\varepsilon_0 R^2}(\hat{i})$

(2) $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(\hat{i})$

(3) $\frac{3\sqrt{3}Q}{16\pi^2\varepsilon_0 R^2}(\hat{i})$

(4) $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(-\hat{i})$



Ans. (2)

QUESTION

Two particles A and B having charges $20\ \mu c$ and $-5\ \mu C$ respectively are held fixed with a separation of 5 cm. At what position a third charged particle should be placed so that it does not experience a net electric force? **[JEE Mains 2021]**

(1) At 5 cm from $20\ \mu C$ on the left side of system

(2) At 5 cm from $-5\ \mu C$ on the right side

(3) At 1.25 cm from $-5\ \mu C$ between two charges

(4) At midpoint between two charges

Ans. (2)

QUESTION

A cube is placed inside an electric field, $\vec{E} = 150y^2\hat{j}$. The side of the cube is 0.5 m and is placed in the field as shown in the given figure. The charge inside the cube is :

[JEE Mains 2021]

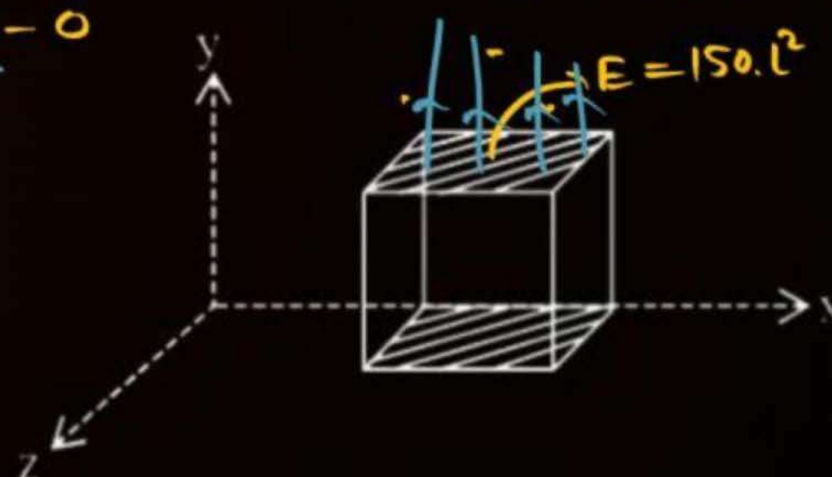
(1) $3.8 \times 10{-}11$ C

(2) $8.3 \times 10{-}11$ C

(3) $3.8 \times 10{-}12$ C

(4) $8.3 \times 10{-}12$ C

$$\frac{q_{in}}{\epsilon_0} = 150 \times l^2 \times l^2 - 0$$



Ans. (2)

QUESTION

A chage of 4μC is to be divided into two. The distance between the two divided charges is constant. The magnitude of the divided charges so that the force between them is maximum, will be: **[JEE Mains 2022]**

(1) 1 μC and 3 μC

(2) 2 μC and 2 μC

(3) 0 μC and 4 μC

(4) 1.5 μC and 2.5 μC

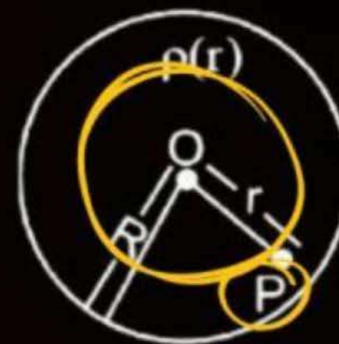
Ans. (2)

QUESTION

$$E\cdot 4\pi r^2 = \frac{\int_0^r \rho 4\pi r^2 dr}{\epsilon_0}$$

A spherically symmetric charge distribution is considered with charge density varying as $\rho(r) = \begin{cases} \rho_0\left(\frac{3}{4} - \frac{r}{R}\right) & \text{for } r \le R \\ \text{Zero} & \text{for } r > R \end{cases}$

Where, $r (r < R)$ is the distance from the centre O (as shown in figure). The electric field at point P will be:



[JEE Mains 2022]

(1) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{3}{4} - \frac{r}{R}\right)$

(2) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{3}{4} - \frac{r}{R}\right)$

(3) $\frac{\rho_0 r}{4\varepsilon_0}\left(1 - \frac{r}{R}\right)$

(4) $\frac{\rho_0 r}{5\varepsilon_0}\left(1 - \frac{r}{R}\right)$

Ans. (3)

$$E = \frac{\int_0^r \rho_0\left(\frac{3}{4} - \frac{r}{R}\right) r^2\, dr}{\epsilon_0 \, r^2}$$

QUESTION

A vertical electric field of magnitude 4.9 × 10^6 N/C just prevents a water droplet of a mass 0.1 g from falling. The value of charge on the droplet will be :

(Given g = 9.8 m/s^2) [JEE Mains 2022]

$mg = qE$

$.1 \times 10^{-3} \times 9.8 = q \times 4.9 \times 10^5$

(1) 1.6×10^{-9} C

(2) 2.0×10^{-9} C

(3) 3.2×10^{-9} C

(4) 0.5×10^{-9} C

Ans. (2)

QUESTION

A long cylindrical volume contains a uniformly distributed charge of density ρ. The radius of cylindrical volume is R. A charge particle (q) resolves around the cylinder in a circular path. The kinetic energy of the particle is : [JEE Mains 2022]

$$qE = \frac{mv^2}{r}$$

(1) $\frac{\rho q R^2}{4\varepsilon_0}$

(2) $\frac{\rho q R^2}{2\varepsilon_0}$

(3) $\frac{q\rho}{4\varepsilon_0 R^2}$

(4) $\frac{4\varepsilon_0 R^2}{q\rho}$

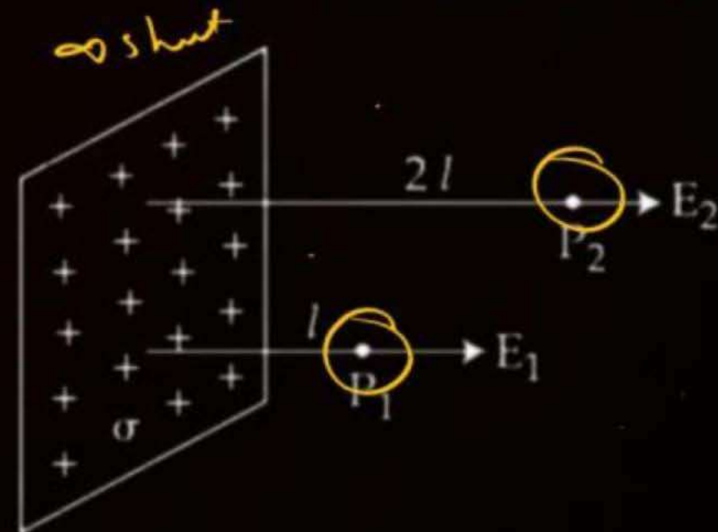
Ans. (1)

QUESTION

In the figure, a very large plane sheet of positive charge is shown. P_1 and P_2 are two points at distance l and 2l from the charge distribution. If σ is the surface charge density, then the magnitude of electric fields E_1 and E_2 at P_1 and P_2 respectively are :

[JEE Mains 2022]

$\frac{\sigma}{2\epsilon_0}$



(1) $E_1 = \sigma/\varepsilon_0, E_2 = \sigma/2\varepsilon_0$

(2) $E_1 = 2\sigma/\varepsilon_0, E_2 = \sigma/\varepsilon_0$

(3) $E_1 = E_2 = \sigma/2\varepsilon_0$

(4) $E_1 = E_2 = \sigma/\varepsilon_0$

Ans. (3)

QUESTION

27 identical drops are charged at 22V each. They combine to form a bigger drop. The potential of the bigger drop will be ______ V.

[JEE Mains 2022]

$\frac{kq}{r} = 22$

$V = \frac{KQ}{R} = \frac{K\,27q}{R} = \frac{K\,27q}{3r}$

$= 9\left(\frac{kq}{r}\right)$

$= 9 \times 22$

$= 198$

$27 \cdot \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$R = 3r$

Ans. 198

QUESTION

If a charge q is placed at the centre a closed hemispherical non-conducting surface, the total flux passing through the flat surface would be : **[JEE Mains 2022]**

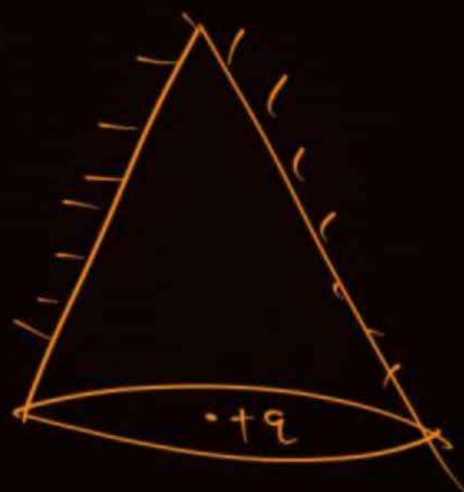
(1) $\frac{q}{\varepsilon_0}$

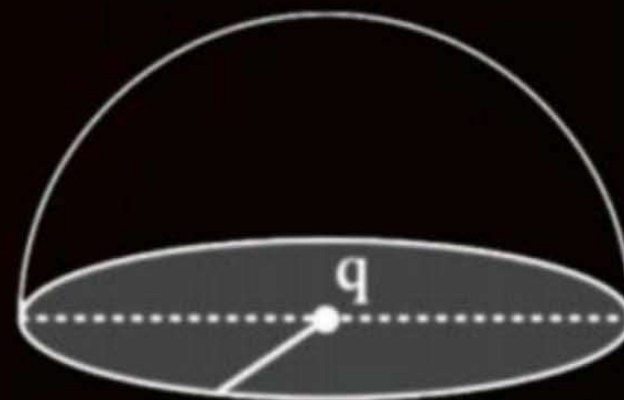
(2) $\frac{q}{2\varepsilon_0}$

(3) $\frac{q}{4\pi\varepsilon_0}$

(4) $\frac{q}{2\pi\varepsilon_0}$

$\frac{q}{2\epsilon_0}$





Ans. (2)

QUESTION

E

$+q \longrightarrow E + \frac{kq}{r^2}$

Given below are two statements :

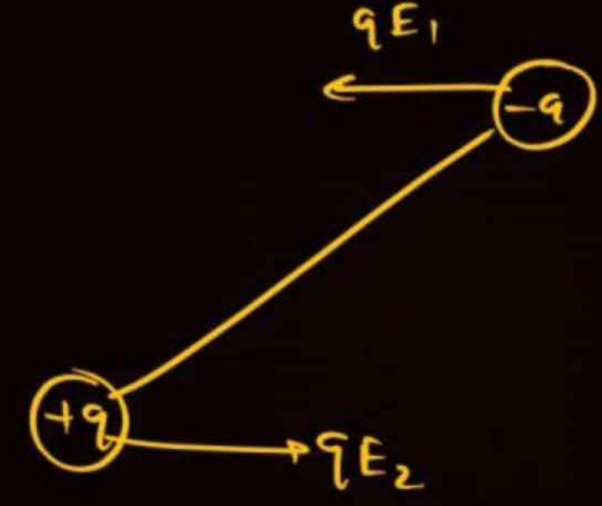
Statement-I : A point charge is brought in an electric field. The value of electric field at a point near to the charge may increase if the charge is positive.

Statement-II : An electric dipole is placed in a non-uniform electric field. The net electric force on the dipole will not be zero

Choose the correct answer from the option given below: **[JEE Mains 2022]**

1. Both statement-I and statement-II are true.
2. Both statement-I and statement-II is false.
3. Statement-I is true but statement-II is false.
4. Statement-I is false but statement-II is true.

Ans. (1)



qE$_1$
-q
+q
qE$_2$

QUESTION

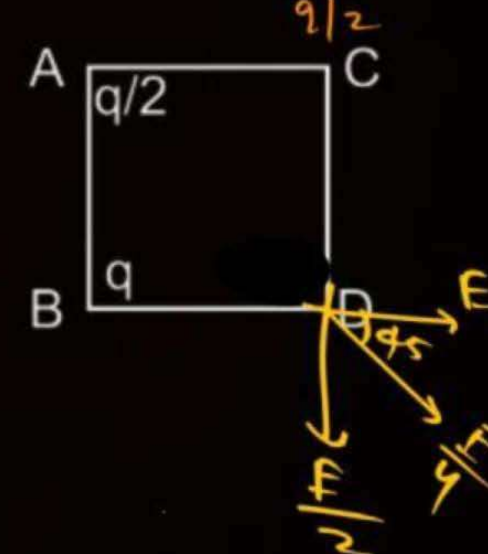
The three charge $q/2$, q and $q/2$ are placed at the corners A, B and C of a square of side 'a' as shown in figure. The magnitude of electric field (E) at the comer D of the square, is :

[JEE Mains 2022]

$$E = \frac{kq}{l^2}$$

$$E' = \frac{k\,q/2}{(l\sqrt{2})^2} = \frac{kq}{4l^2}$$

Concept



(1) $\frac{q}{4\pi \epsilon_0 a^2}\left(\frac{1}{\sqrt{2}} + \frac{1}{2}\right)$

(2) $\frac{q}{4\pi \epsilon_0 a^2}\left(1 + \frac{1}{\sqrt{2}}\right)$

(3) $\frac{q}{4\pi \epsilon_0 a^2}\left(1 - \frac{1}{\sqrt{2}}\right)$

(4) $\frac{q}{4\pi \epsilon_0 a^2}\left(\frac{1}{\sqrt{2}} - \frac{1}{2}\right)$

Ans.

QUESTION

If the electric potential at any point (x, y, z)m in space is given by $V = 3x^2$ volt. The electric field at the point $(1, 0, 3)$ m will be : [JEE Mains 2022]

$E = -\frac{dV}{dx}$

$\boxed{E = -6x\hat{i}}$

$E = -6\hat{i}$

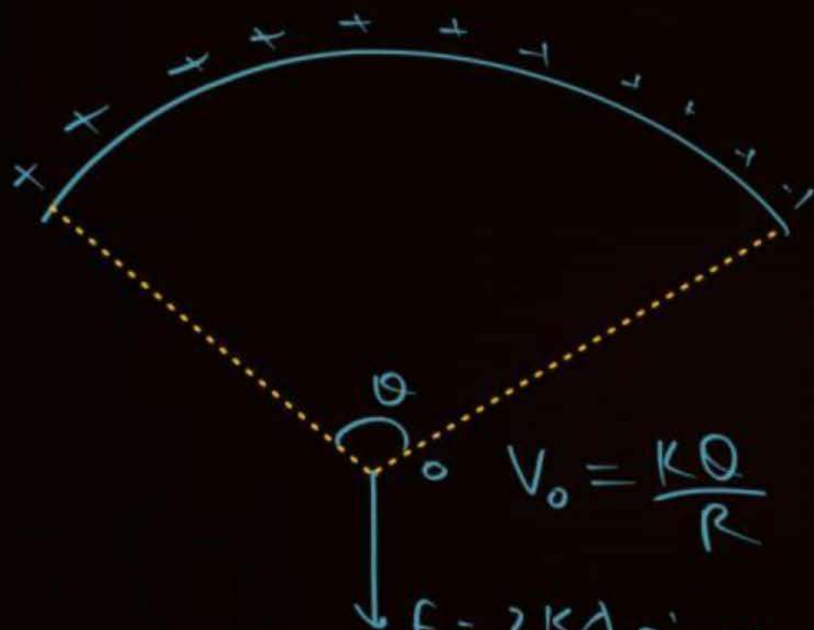
(1) $3\,Vm^{-1}$, directed along positive $x -$ axis.

(2) $3\,Vm^{-1}$, directed along negative $x -$ axis.

(3) $6\,Vm^{-1}$, directed along positive $x -$ axis.

(4) $6\,Vm^{-1}$, directed along negative $x -$ axis

Ans. (4)



$$V_0 = \frac{KQ}{R}$$

$$E = \frac{2K\lambda}{R}\sin\theta/2$$

QUESTION

If two charges q_1 and q_2 are separated with distance 'd' and placed in a medium of dielectric constant K. What will be the equivalent distance between charges in air for the same electrostatic force?

[24 January 2023 - Shift 1]

(1) $d\sqrt{k}$

$$\frac{q_1 q_2}{4\pi\epsilon_0 K \lambda^2} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{\lambda'^2}$$

(2) $k\sqrt{d}$

(3) $1.5d\sqrt{k}$

(4) $2d\sqrt{k}$

Ans : (1)

QUESTION

The electric potential at the centre of two concentric half rings of radii R_1 and R_2, having same linear charge density λ is

[24 January 2023 - Shift 2]

(1) $\dfrac{2\lambda}{\epsilon_0}$

(2) $\dfrac{\lambda}{2\epsilon_0}$

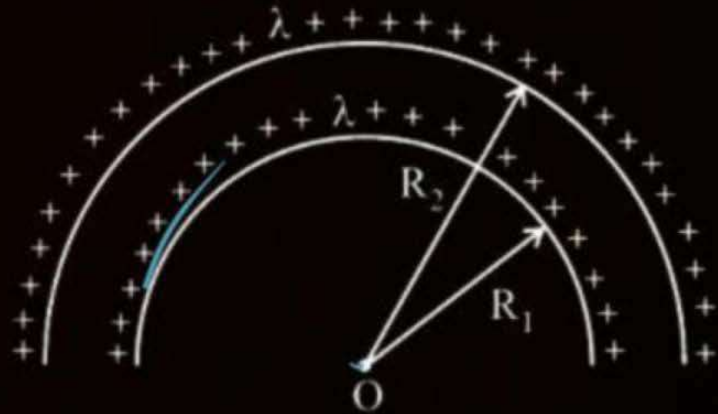
(3) $\dfrac{\lambda}{4\epsilon_0}$

(4) $\dfrac{\lambda}{\epsilon_0}$

$\dfrac{Kq_1}{R_1} + \dfrac{Kq_2}{R_2}$

$\dfrac{K\lambda\pi R_1}{R_1} + \dfrac{K\lambda\pi R_2}{R_2}$

$\dfrac{1}{4\pi\epsilon_0}\lambda\pi \times 2$



Ans : (2)

QUESTION

$E = \frac{\sigma}{\epsilon_0} = 10$

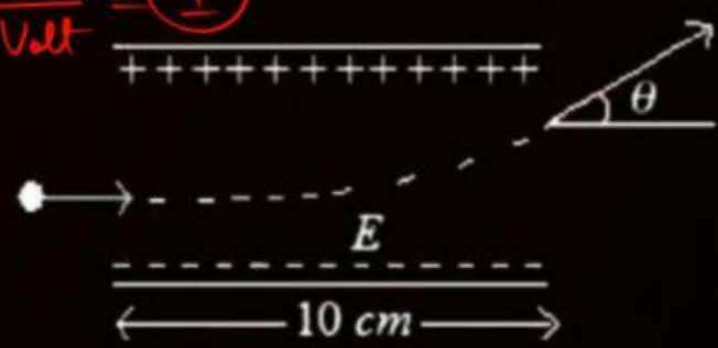
A uniform electric field of 10 N/C is created between two parallel charged plates (as shown in figure). An electron enters the field symmetrically between the plates with a kinetic energy 0.5eV. The length of each plate is 10 cm. The angle (θ) of deviation of the path of electron as it comes out of the field is ________ (in degree).

[25 January 2023 - Shift 1]

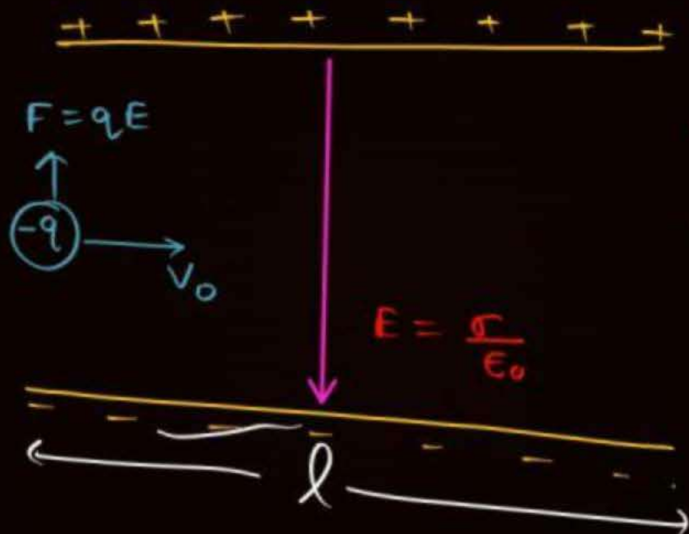
$\tan\theta = \frac{qE\ell}{m v_0^2} = \frac{\cancel{e} \times 10 \times .1}{1\,\cancel{e}\,\text{Volt}} = 1$

$.5\,eV = \frac{1}{2} m v_0^2$

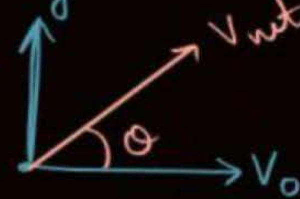
45°



Ans : (45)



$$V_y = 0 + at = \frac{qE}{m}\frac{l}{V_0}$$



$$\tan\theta = \frac{V_y}{V_0}$$

$$\tan\theta = \frac{qEl}{mV_0\,V_0} = \frac{qEl}{mV_0^2}$$

QUESTION

A point charge of 10 μC is placed at the origin. At what location on the X-axis should a point charge of 40 μC be placed so that the net electric field is zero at x = 2 cm on the X-axis ?

q

[25 January 2023 - Shift 2]

$x=0$ $x=2$ 4q

q $E=0 \xleftarrow{\quad x \quad} \rightarrow$

$$\frac{kq}{2^2} = \frac{k(4q)}{x^2}$$

$x = 4$

(1) x = 6 cm

(2) x = 4 cm

(3) x = 8 cm

(4) x = −4 cm

Ans : (1)

QUESTION

Match List – I with List – II :

[25 January 2023 - Shift 2]

List-I		List-II	
(A)	Gauss's Law in Electrostatics	(I)	$\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$
(B)	Faraday's Law	(II)	$\oint \vec{B} \cdot d\vec{A} = 0$
(C)	Gauss's Law in Magnetism	(III)	$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_C + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$
(D)	Ampere-Maxwell Law	(IV)	$\oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$

QUESTION

A point charge $q_1 = 4q_0$ is placed at origin. Another point charge $q_2 = -q_0$ is placed at $x = 12$ cm. Charge of proton is q_0. The proton is placed on x-axis so that the electrostatic force on the proton in zero. In this situation, the position of the proton from the origin is 24 cm.

[29 January 2023 - Shift 1]

$$\frac{K\,4q_0 q}{(12+x)^2} = \frac{K q_0 q_0}{x^2}$$

$$\frac{2}{12+x} = \frac{1}{x}$$

$$2x = 12 + x$$

$$x = 12$$

Ans : (24)

QUESTION

$\sigma = \frac{q}{\text{Area}}$

Two isolated metallic solid spheres of radii R and 2R are charged such that both have same charge density σ. The spheres are then connected by a thin conducting wire. If the new charge density of the bigger sphere is σ'. The ratio $\frac{\sigma'}{\sigma}$ is:

[30 January 2023 - Shift 1]

(1) $\frac{9}{4}$

(2) $\frac{4}{3}$

(3) $\frac{5}{3}$

(4) $\frac{5}{6}$

$q_1 = \sigma . 4\pi R^2 = Q_0$

$q_2 = \sigma . 4\pi (2R)^2 = 4Q_0$

$x = \frac{10Q}{3}$

$V_A = V_B$

$\frac{K(5Q - x)}{R} = \frac{Kx}{2R}$

$10Q - 2x = x$

$\sigma' = \frac{\frac{10Q_0}{3}}{4\pi (2R)^2}$

$\sigma' = \frac{10\ Q_0}{3 \times 16\pi R^2}$

$= \frac{10 \times \sigma 4\pi R^2}{48\ \pi R^2}$

$= \frac{10}{12}\sigma$

Ans : (4)

QUESTION

As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II and III is given by :
(I : $r < a$, II : $a < r < b$, III : $r > b$)

[30 January 2023 - Shift 2]

$E_I \neq 0$
$E_{II} = 0$
$E_{III} \neq 0$

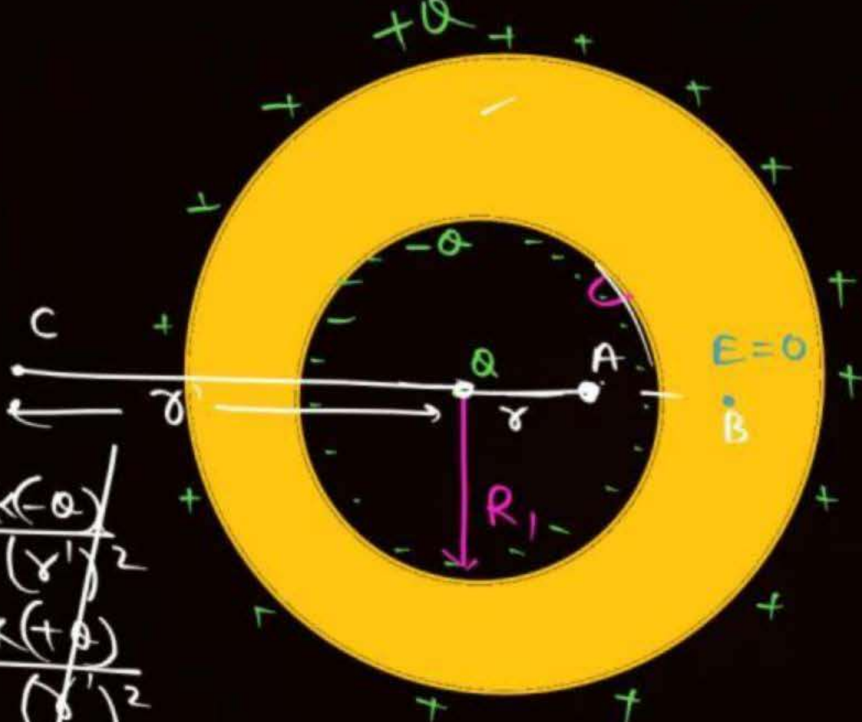
(1) $E_I = 0, E_{II} = 0, E_{III} \neq 0$

(2) $E_I \neq 0$, EII=0, EIII $\neq 0$

(3) $E_I \neq 0, E_{II} = 0, E_{III} = 0$

(4) $E_I = 0, E_{II} = 0, E_{III} = 0$

Ans : (2)



1 point charge, 2 shell

$$\sigma_{inner} = \frac{-Q}{4\pi R_1^2}$$

$$\sigma_{outer} = \frac{+Q}{4\pi R_2^2}$$

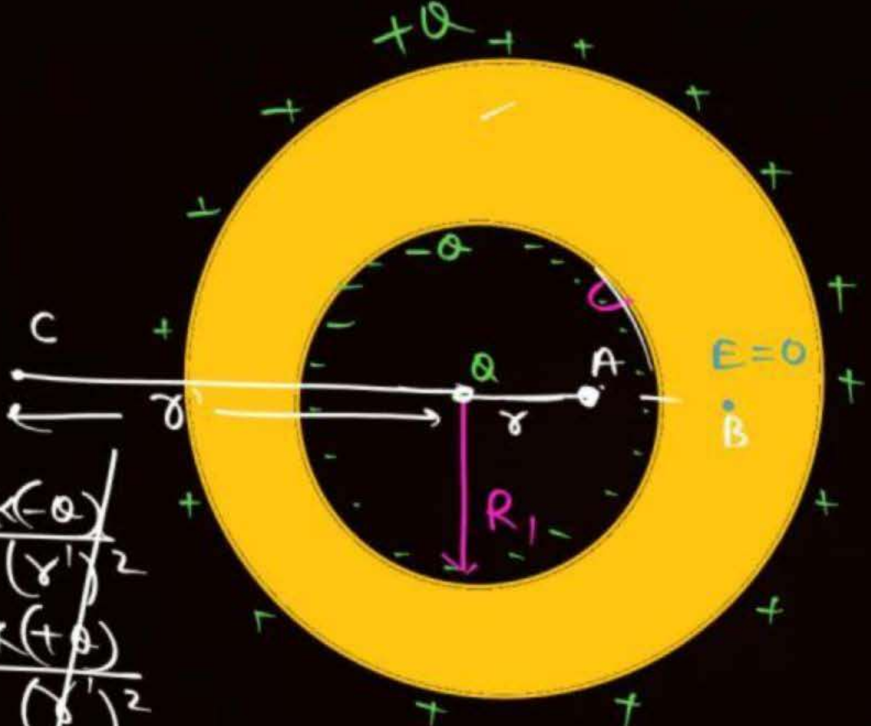
$$E_c = \frac{KQ}{(r')^2} + \cancel{\frac{K(-Q)}{(r')^2}} + \cancel{\frac{K(+Q)}{(r')^2}}$$

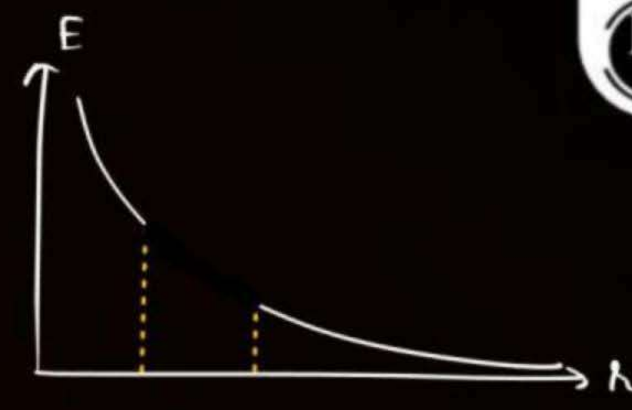
$$\boxed{E_c = \frac{KQ}{r'^2}}$$

$$E_A = \frac{KQ}{(r)^2} + 0 + 0$$

$$E_B = 0$$

$$\frac{KQ}{r^2} +$$





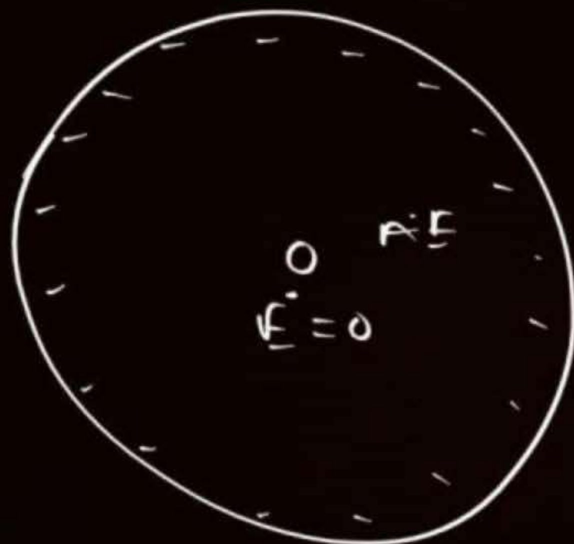
$$E_c = \frac{KQ}{(r')^2} + \frac{K(-Q)}{(r')^2} + \frac{K(+Q)}{(r')^2}$$

$$E_c = \frac{KQ}{r'^2}$$

$$E_A = \frac{KQ}{(r)^2} + 0 + 0$$

$$E_B = 0$$

$$\frac{KQ}{r^2} +$$


O
A
E = 0

QUESTION

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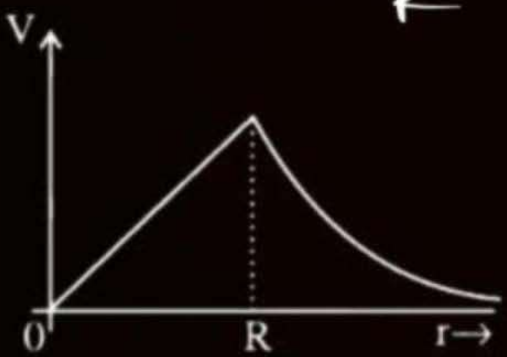
Which of the following correctly represents the variation of electric potential (V) of a charged spherical conductor of radius (R) with radial distance (r) from the centre?

$\frac{KQ}{R}$ $\frac{KQ}{r}$

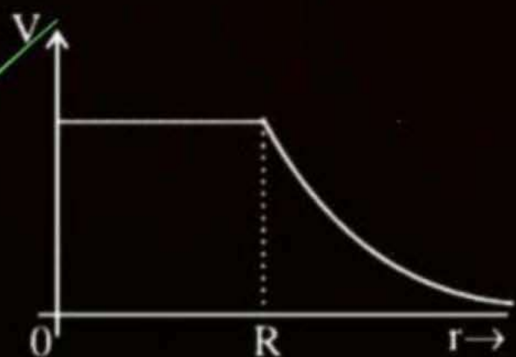
[31 January 2023 - Shift 1]

(1)

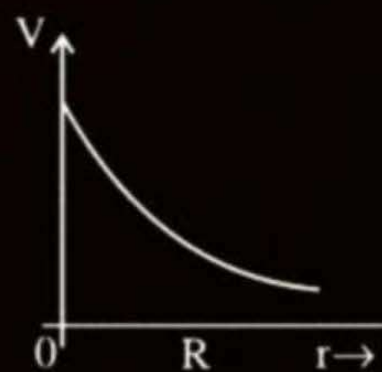


(2)

(3)



(4)



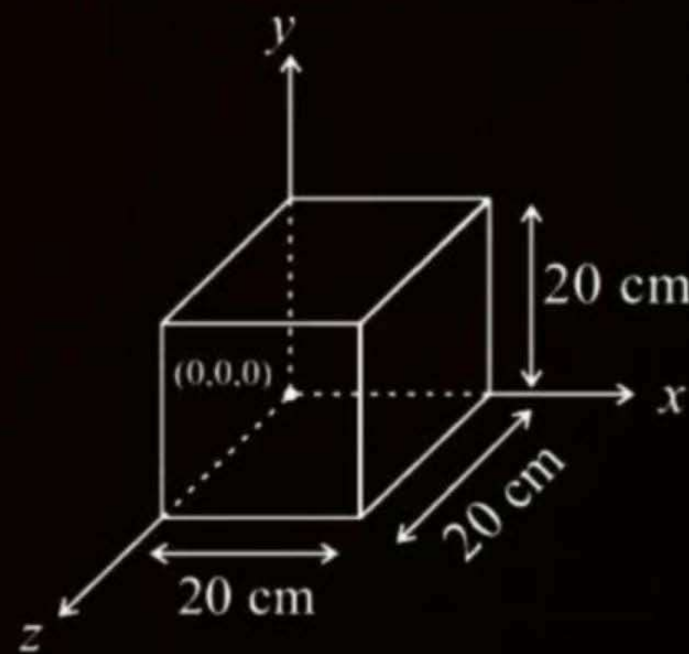
Ans : (3)

QUESTION

Expression for an electric field is given by $\vec{E} = 4000x^2\hat{i}\frac{V}{m}$. The electric flux through the cube of side 20 cm when placed in electric field (as shown in the figure) is ________ V cm.

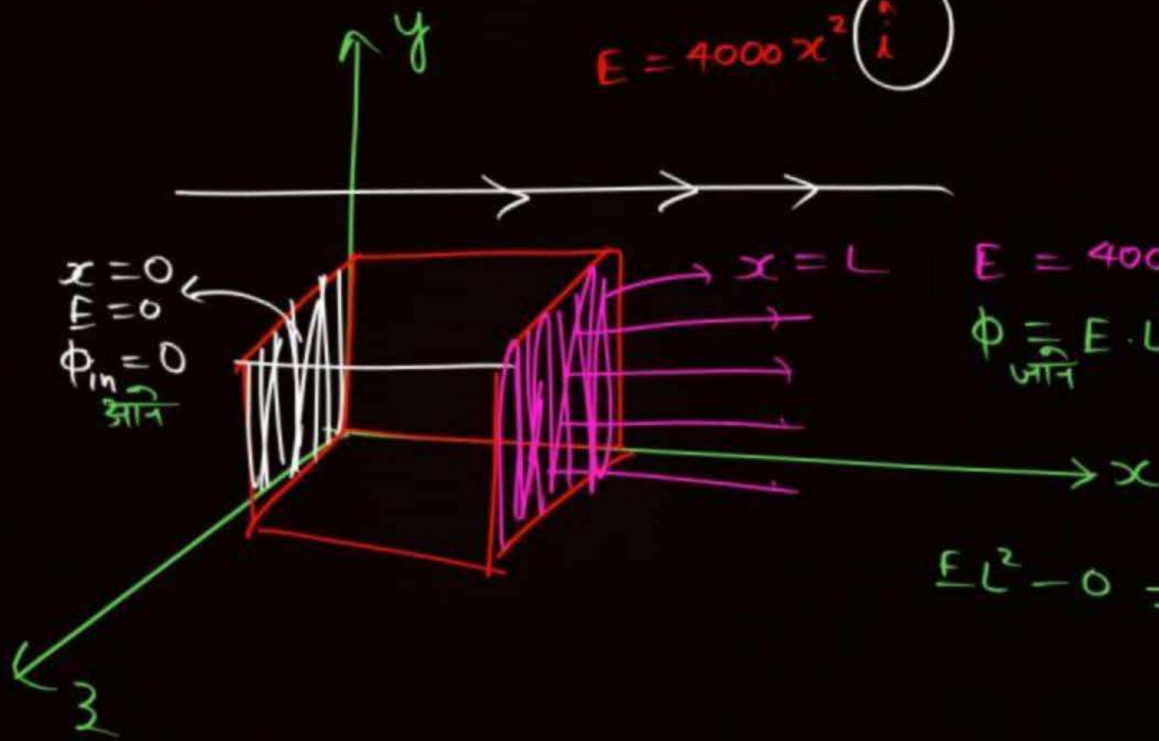
[31 January 2023 - Shift 1]

$$\phi_{net} = \frac{q_{in}}{\epsilon_0} = 4000\,l^2 \times l^2 - 0$$



Ans : (640)

$E = 4000\,x^2\,\hat{i}$



$x = 0$

$E = 0$

$\phi_{in} = 0$

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$E = 4000\,L^2$

$\phi = E \cdot L^2$

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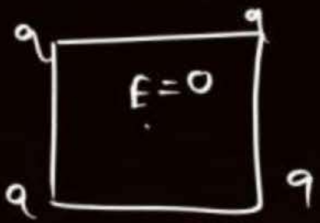
$$E L^2 - 0 = \frac{q_{in}}{\epsilon_0}$$

QUESTION

Considering a group of positive charges, which of the following statements is correct?

[31 January 2023 - Shift 2]



(1) Net potential of the system cannot be zero at a point but net electric field can be zero at that point.

(2) Net potential of the system at a point can be zero but net electric field can't be zero at that point.

(3) Both the net potential and the net field can be zero at a point.

(4) Both the net potential and the net electric field cannot be zero at a point.

Ans : (1)

QUESTION

Let σ be the uniform surface charge density of two infinite thin plane sheets shown in figure. Then the electric fields in three different region E_I, E_{II} and E_{III} are :

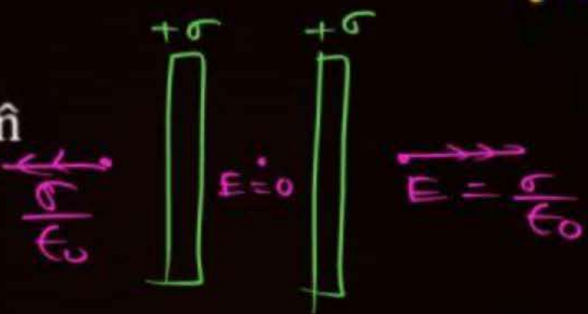
[01 February 2023 - Shift 1]

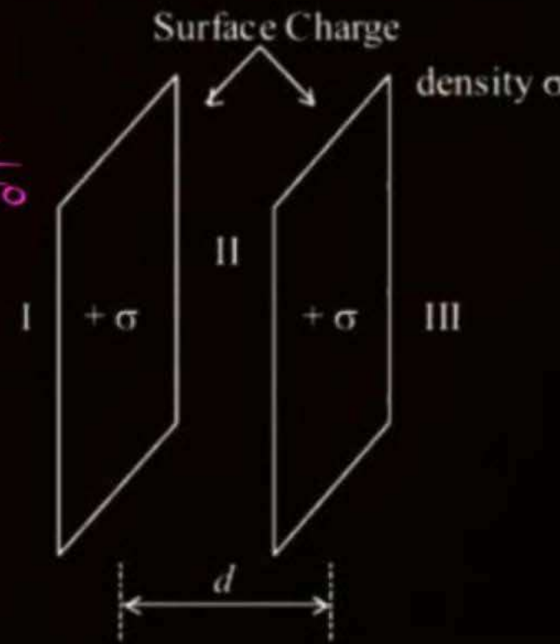
(1) $\vec{E}_I = \frac{2\sigma}{\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{\epsilon_0}\hat{n}$

(2) $\vec{E}_I = 0, \vec{E}_{II} = \frac{\sigma}{\epsilon_0}\hat{n}, \vec{E}_{III} = 0$

(3) $\vec{E}_I = \frac{\sigma}{2\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{2\epsilon_0}\hat{n}$

(4) $\vec{E}_I = -\frac{\sigma}{\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{\epsilon_0}\hat{n}$



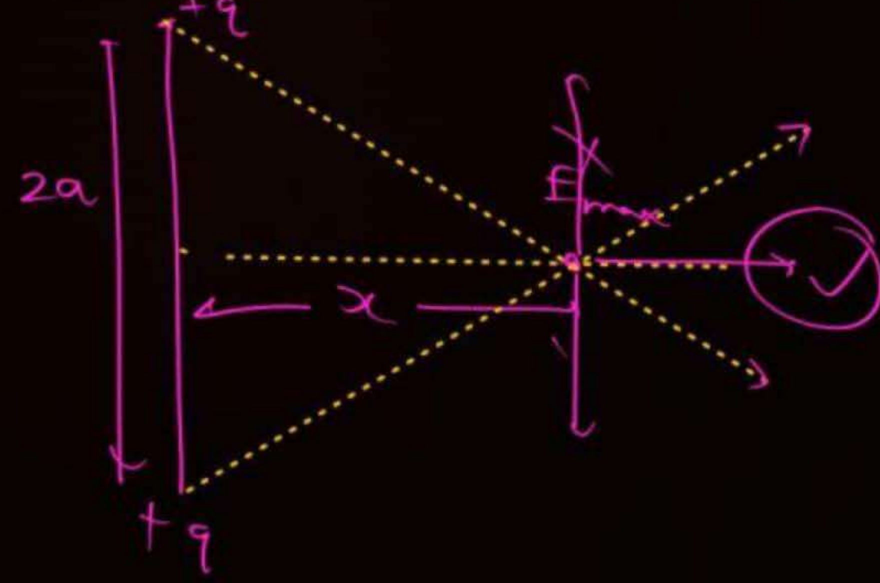


Ans : (4)

QUESTION

Two equal positive point charges are separated by a distance 2a. The distance of a point from the centre of the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge q_0 becomes maximum is $\frac{a}{\sqrt{x}}$. The value of x is ________.

[01 February 2023 - Shift 1]

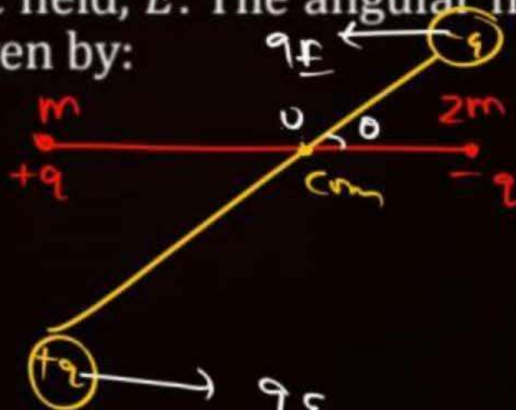


Ans : (2)

QUESTION

$$I = m\left(\frac{2l}{3}\right)^2 + (2m)\left(\frac{l}{3}\right)^2$$

A dipole comprises of two charged particles of identical magnitude q and opposite in nature. The mass m of the positive charged particle is half of the mass of the negative charged particle. The two charges are separated by a distance l. If the dipole is placed in a uniform electric field $\vec{E}$; in such a way that dipole axis makes a very small angle with the electric field, $\vec{E}$. The angular frequency of the oscillations of the dipole when released is given by: [06 April 2023 - Shift 2]



(1) $\sqrt{\frac{3qE}{2ml}}$

(2) $\sqrt{\frac{8qE}{ml}}$

(3) $\sqrt{\frac{4qE}{ml}}$

(4) $\sqrt{\frac{8qE}{3ml}}$

$$\tau = qE\frac{l}{3}\sin\theta + qE\frac{2l}{3}\sin\theta$$

$$\tau = qEl\,\theta$$

$$T = 2\pi\sqrt{\frac{I}{pE}}$$

Ans : (1)

QUESTION

An electric dipole of dipole moment is 6.0×10^{-6} C placed in a uniform electric field of 1.5×10^{3} N C^{-1} in such a way that dipole moment is along electric field. The work done in rotating dipole by 180° in this field will be 18 mJ.

[08 April 2023 - Shift 1]

$\theta_1 = 0$

$\theta_2 = 180$

$WD = -pE(\cos\theta_2 - \cos\theta_1)$

$WD = -pE(-1-1)$

$= 2pE = 2 \times 6 \times 10^{-6} \times 1.5 \times 10^{+3}$

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

Ans : (18)

QUESTION

Electric potential at a point P due to a point charge of 5×10^{-9} C is 50 V. The distance of P from the point charge is: (Assume, $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^{9} \mathrm{Nm^2C^{-2}}$)

[08 April 2023 - Shift 2]

(1) 9 cm

(2) 3 cm

(3) 0.9 cm

(4) 90 cm

$$\frac{KQ}{r} = V$$

$$\frac{9 \times 10^{9} \times 5 \times 10^{-9}}{r} = 50$$

$$r = \frac{9}{10} \text{ m} = 90 \text{ cm}$$

$$= .9 \text{ m}$$

Ans : (4)

QUESTION

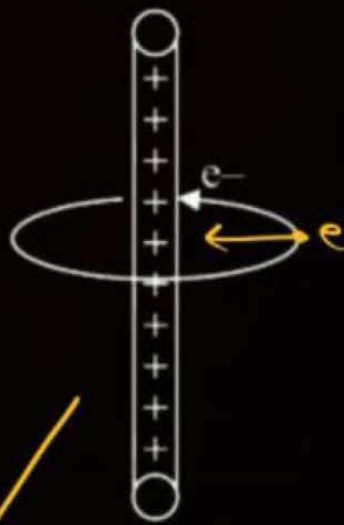
An electron revolves around an infinite cylindrical wire having uniform linear charge density 2×10^{-8} C m^{-1} in circular path under the influence of attractive electrostatic field as shown in the figure. The velocity of electron with which it is revolving is ________ $\times 10^{6}$ m s^{-1}. Given mass of electron $= 9 \times 10^{-31}$ kg

[10 April 2023 - Shift 2]

$$F = \frac{2k\lambda}{r} e = \frac{mv^2}{r} = mr\omega^2$$

$$v = \sqrt{\frac{2k\lambda e}{m}} = \text{independ on } r$$

$$= \sqrt{\frac{2 \times 9 \times 10^{9} \times 2 \times 10^{-8} \times 1.6 \times 10^{-19}}{9 \times 10^{-31}}} = \checkmark$$



Ans : (8)

QUESTION

If V is the gravitational potential due to sphere of uniform density on its surface, then its value at the centre of sphere will be: [11 April 2023 - Shift 2]

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

$$\frac{3}{2}\frac{KQ}{R} = V'$$

(1) $\frac{4}{3}V$

(2) $\frac{V}{2}$

(3) V

(4) $\frac{3V}{2}$

Ans : (4)

QUESTION

$\phi = \frac{q_{in}}{\epsilon_0} = \frac{-q+q}{\epsilon_0} = 0$

Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : If an electric dipole of dipole moment 30×10^{-5} C m is enclosed by a closed surface, the net flux coming out of the surface will be zero.

Reason R : Electric dipole consists of two equal and opposite charges.

In the light of above, statements, choose the correct answer from the options given below. **[12 April 2023 - Shift 1]**

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

(2) A is false but R is true

(3) A is true but R is false

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

Ans : (1)

QUESTION

Two charges of each magnitude 0.01 C and separated by a distance of 0.4 mm constitute an electric dipole. If the dipole is placed in an uniform electric field $\vec{E}$ of 10 dyne C^{-1} making 30° angle with $\vec{E}$ the magnitude of torque acting on dipole is:

[13 April 2023 - Shift 1]

$\vec{\tau} = \vec{P} \times \vec{E}$

$\tau = PE \sin 30$

$\tau = q d E \frac{1}{2} = \frac{1}{100} \times \frac{.4 \times 10^{-3} \times 10 \times 10^{-5}}{2}$

1. 4.0×10^{-10} N m
2. 1.0×10^{-8} N m
3. 1.5×10^{-9} N m
4. 2.0×10^{-10} N m

Ans : (4)

QUESTION

q_1

q_2

A 10 μC charge is divided into two parts and placed at 1 cm distance so that the repulsive force between them is maximum. The charges of the two parts are:

[13 April 2023 - Shift 2]

$$F = \frac{K q_1 q_2}{r^2}$$

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max

(1) 7 μC, 3 μC

(2) 8 μC, 2 μC

(3) 5 μC, 5 μC

(4) 9 μC, 1 μC

Ans : (3)

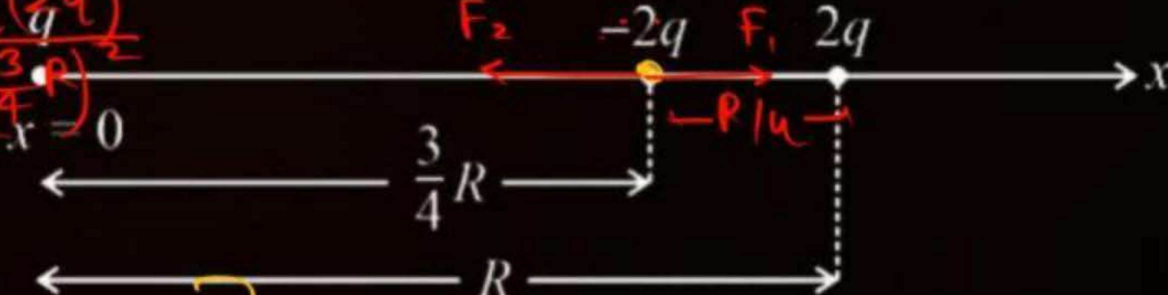
QUESTION

Three point charges q, −2q and 2q are placed on x axis at a distance x = 0, x = $\frac{3}{4}$ R and x = R respectively from origin as shown. If q = 2 × 10^{-6} C and R = 2 cm, the magnitude of net force experienced by the charge −2q is ________ N.

[13 April 2023 - Shift 2]

$$F_{net} = F_1 - F_2$$

$$= \frac{K\,2q\,2q}{\left(\frac{R}{4}\right)^2} - \frac{Kq(2q)}{\left(\frac{3}{4}R\right)^2}$$



$$= \frac{Kq^2}{R^2}\left[4 \times 16 - \frac{2 \times 16}{9}\right] = 5440$$

Ans : (5440)

QUESTION

The electric field due to a short electric dipole at a large distance (r) from center of dipole on the equatorial plane varies with distance as : [15 April 2023 - Shift 1]

$-\frac{K\vec{p}}{r^3}$

(1) r

(2) $\frac{1}{r^2}$

(3) $\frac{1}{r^3}$

(4) $\frac{1}{r}$

Ans : (3)

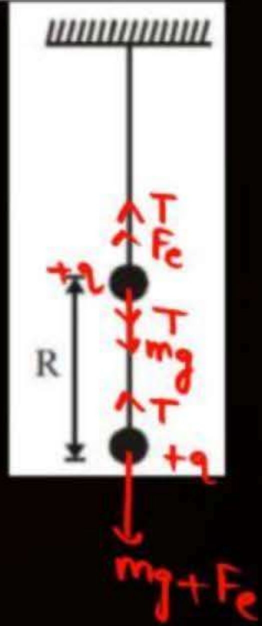
QUESTION

Two identical balls of mass m = 0.9 g each are charged by the same charges, joined by a thread and suspended from the ceiling (figure). Find the charge (in μC) that each ball should have so that the tension in both the threads are same? The distance between the centers of balls is R = 3m.

$$T + F_e = mg + T$$

$$F_e = mg$$

$$\frac{Kq^2}{R^2} = mg$$

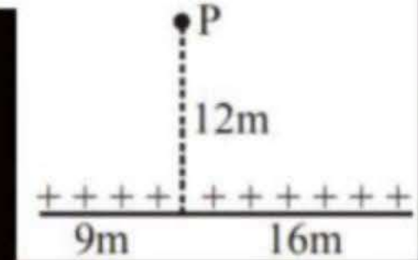


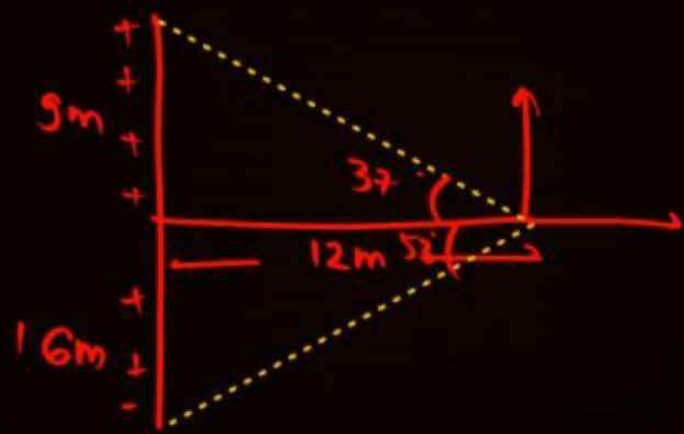
Ans : 03

QUESTION

Find the magnitude of electric field (in N/C) due to a line charge of $\lambda = \left(2\sqrt{2}\right)$ nC/m at a point P as shown.

$\sqrt{E_{\parallel}^2 + E_{\perp}^2}$

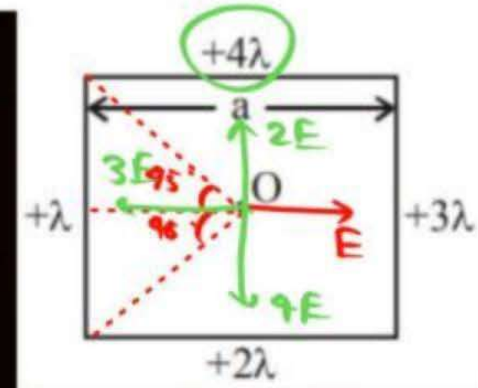




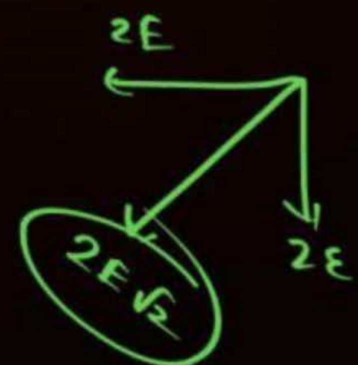
Ans : 3

QUESTION

Four uniformly charged wires of length a are arranged to form a square. Linear charge density of each wire is as shown. Electric field intensity at centre of square is $\frac{nk\lambda}{a}$ then value of n



$$E = \frac{k\lambda}{\ell/2}\left(\sin 45^\circ + \sin 45^\circ\right) = 2\sqrt{2}\frac{k\lambda}{r}$$



Ans : 8

QUESTION

JEE mains expected

A sphere of radius R has charge density given by $\rho = \rho_0\left(1 - \frac{nr}{3R}\right)$, where ρ_0 is a constant, r is distance from centre of sphere. For a spherical gaussian surface of radius R centered at the centre of sphere, the flux is zero. Find 'n'.

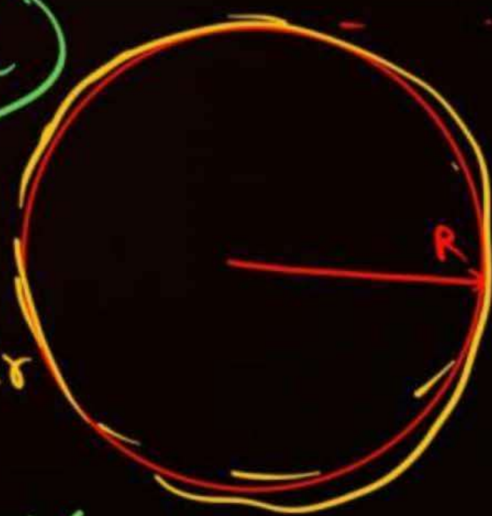
$n = 4$

$$\phi = \frac{Q_{in}}{\epsilon_0} = \frac{\int dq}{\epsilon_0} = \frac{\int \rho\, dV}{\epsilon_0}$$

$\phi = 0$

$$0 = \int_0^R \rho_0\left(1 - \frac{nr}{3R}\right) 4\pi r^2\, dr$$

$$\cancel{\rho_0}\, \cancel{4\pi} \times \frac{R^3}{3} = \frac{n}{3R}\, \cancel{4\pi}\, \frac{R^4}{4}\, \cancel{\rho_0}$$



Ans : 4

QUESTION

Consider the configuration of a system of four charges each of value +q. Find the work done by external agent in changing the configuration of the system from figure (i) to fig (ii).

$(WD)_{ext} = \Delta U = U_f - U_i$

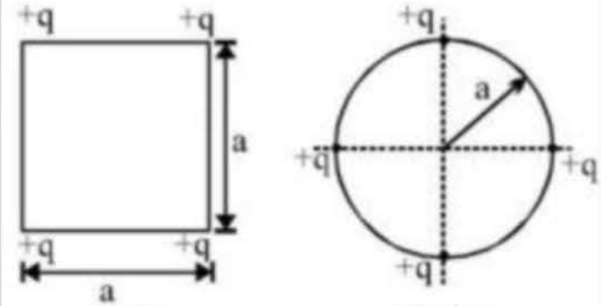


fig (i) fig (ii)

Ans : $-\frac{kq^2}{a}\left(3-\sqrt{2}\right)$

QUESTION

The variation of electric field between the two charges q_1 and q_2 along the line joining the charges is plotted against distance from q_1 (taking rightward direction of electric field as positive) as shown in the figure. Then the correct statement is :-

(A) q_1 and q_2 are positive and $q_1 < q_2$

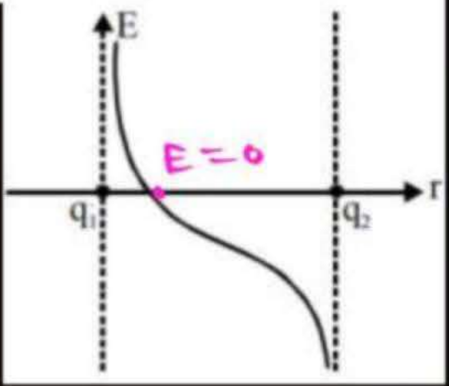
(B) q_1 and q_2 are positive and $q_1 > q_2$

(C) q_1 is positive and q_2 is negative and $q_1 < q_2$

(D) q_1 and q_2 are negative and $q_1 < q_2$

$|q_1| < |q_2|$

$q_1 > 0$. $q_2 > 0$



Ans : (A)

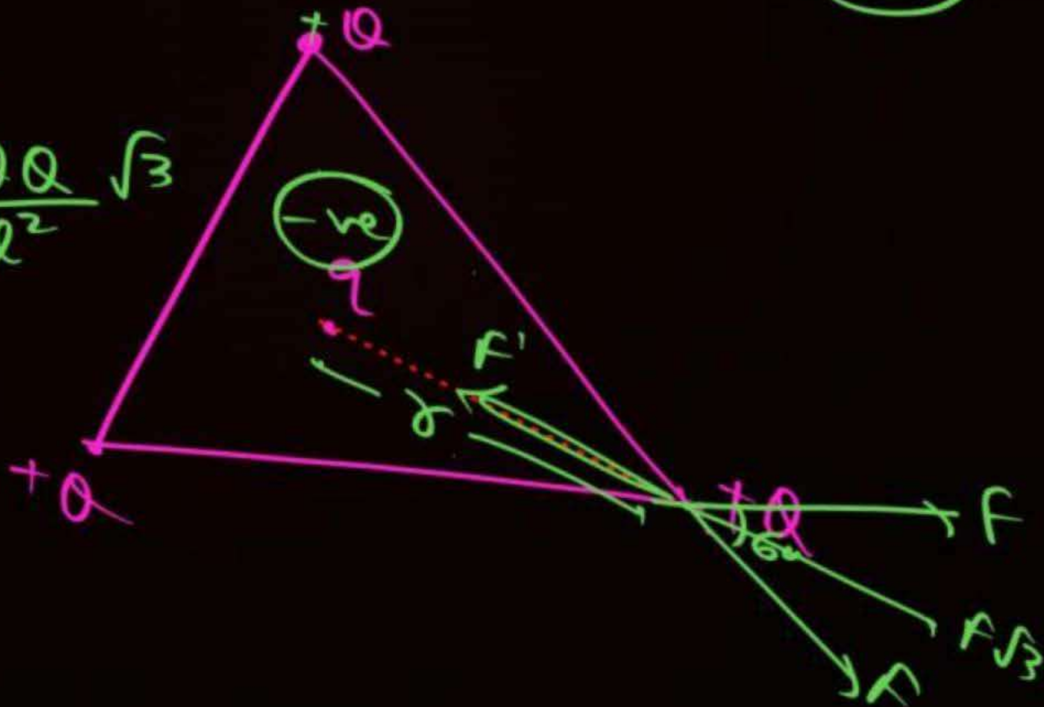
QUESTION

A charge q is placed at the centroid of an equilateral triangle. Three equal charges Q are placed at the vertices of the triangle. The system of four charges will be in equilibrium if q is equal to :-

(A*) $\frac{-Q}{\sqrt{3}}$ (B) $\frac{-Q}{3}$ (C) $-Q\sqrt{3}$ (D) $\frac{Q}{\sqrt{3}}$

$$F' = F\sqrt{3}$$

$$\frac{kqQ}{r^2} = \frac{kQQ}{l^2}\sqrt{3}$$



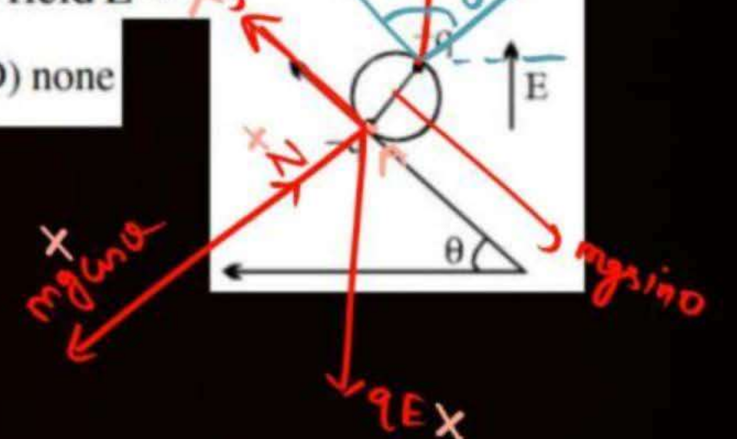
Ans : (A)

QUESTION

A wheel having mass m has charges +q and –q on diametrically opposite points. It remains in equilibrium on a rough inclined plane in the presence of uniform vertical electric field E =

(A) $\frac{mg}{q}$ (B) $\frac{mg}{2q}$ (C) $\frac{mg\tan\theta}{2q}$ (D) none

2min



$\tau_A = 0$

$mg\cancel{\sin\theta} \times \cancel{R} = qE\cancel{\sin\theta} \times 2\cancel{R}$

$E = \frac{mg}{2q}$

Ans : (B)

QUESTION

A particle of mass m and charge q is attached to a light rod of length L. The rod can rotate freely in the plane of paper about the other end, which is hinged at P. The entire assembly lies in a uniform electric field E also acting in the plane of paper as shown. The rod is released from rest when it makes an angle θ with the electric field direction. Determine the speed of the particle when the rod is parallel to the electric field.

(A*) $\left(\frac{2qEL(1-\cos\theta)}{m}\right)^{1/2}$

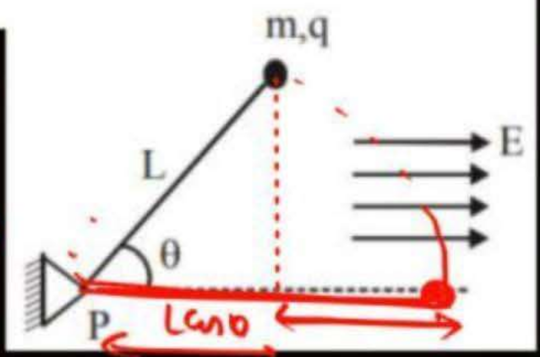
(B) $\left(\frac{2qEL(1-\sin\theta)}{m}\right)^{1/2}$

(C) $\left(\frac{qEL(1-\cos\theta)}{2m}\right)^{1/2}$

(D) $\left(\frac{2qEL\cos\theta}{m}\right)^{1/2}$

$W_{hing} + W_{EF} = \Delta KE$

$0 + qE(L - L\cos\theta) = \frac{1}{2}mv^2 - 0$

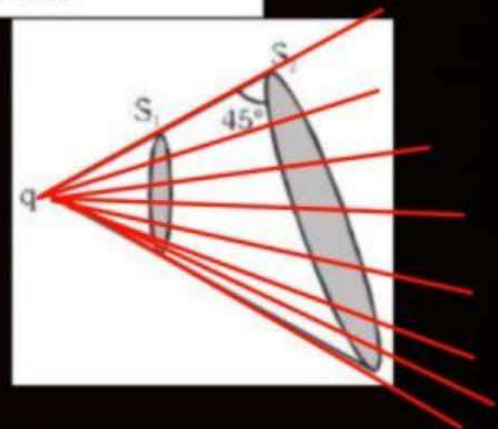


Ans : (A)

QUESTION

In the given figure flux through surface S_1 is ϕ_1 & through S_2 is ϕ_2. Which is correct ?

(A) $\phi_1 = \phi_2$ (B) $\phi_1 > \phi_2$ (C) $\phi_1 < \phi_2$ (D) None of these



Ans : (A)

QUESTION

Two positively charged particles X and Y are initially far away from each other and at rest. X begins to move towards Y with some initial velocity. The total momentum and energy of the system are p and E.

(A) If Y is fixed, both p and E are conserved.

(B) If Y is fixed, E is conserved, but not p.

(C) If both are free to move, p is conserved but not E.

(D) If both are free, E is conserved, but not p.

E = K.E + P.E.

+q ∞ पर

+q

y

fix

x

V_0

PX, KEX

→ KE → not conserve

Conserve

P →

KE →

P.E →

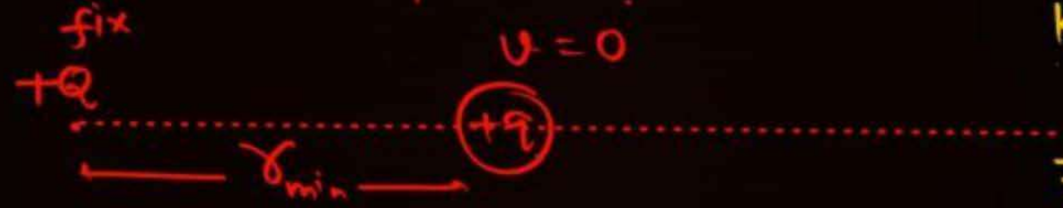
T.E →

E → total energy → conserve

P.E + K.E

Ans : (B)

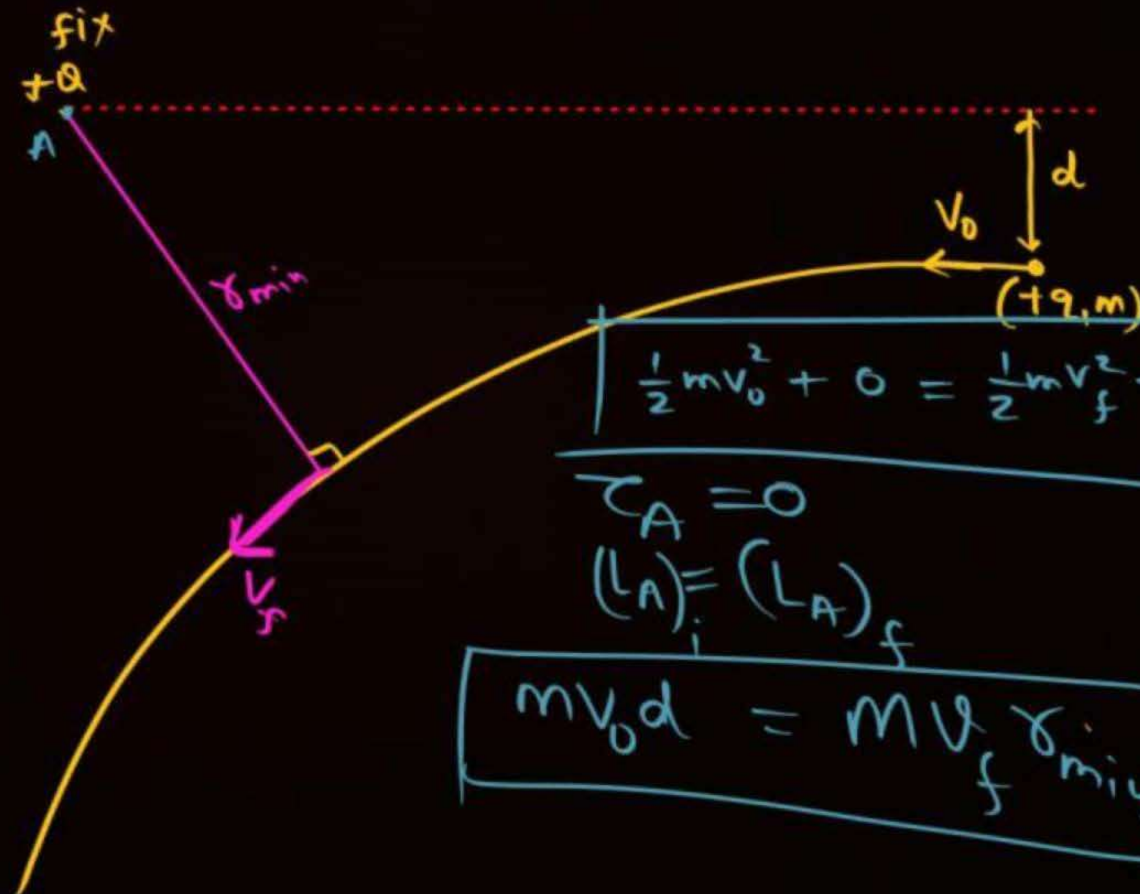
min separation = ?



$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2} m v_0^2 + 0 = 0 + \frac{KQq}{r_{min}}$$

$r_{min} = ?$



$$\boxed{\frac{1}{2}mv_0^2 + 0 = \frac{1}{2}mv_f^2 + \frac{KQq}{r_{min}}}$$

$$\tau_A = 0$$

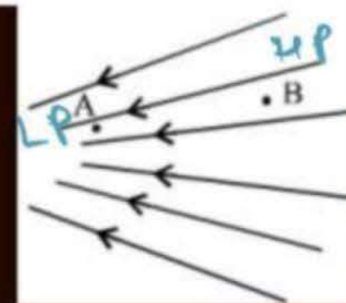
$$(L_A)_i = (L_A)_f$$

$$\boxed{mv_0 d = mv_f r_{min}}$$

QUESTION

Which of the following is true for the figure showing electric lines of force? (E is electrical field, V is potential)

(A) $E_A > E_B$ (B) $E_B > E_A$ (C) $V_A > V_B$ (D) $V_B > V_A$



$\mathcal{E}_A > \mathcal{E}_B$

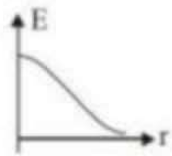
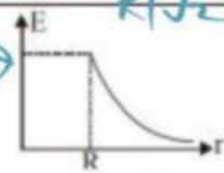
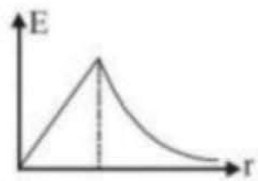
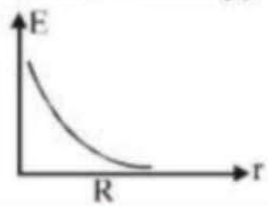
$V_B > V_A$

Ans : (A, D)

QUESTION

MATRIX MATCH TYPE QUESTION

Column II corresponds to the graph of magnitude of electric field versus distance from centre of charge distribution in Column I.

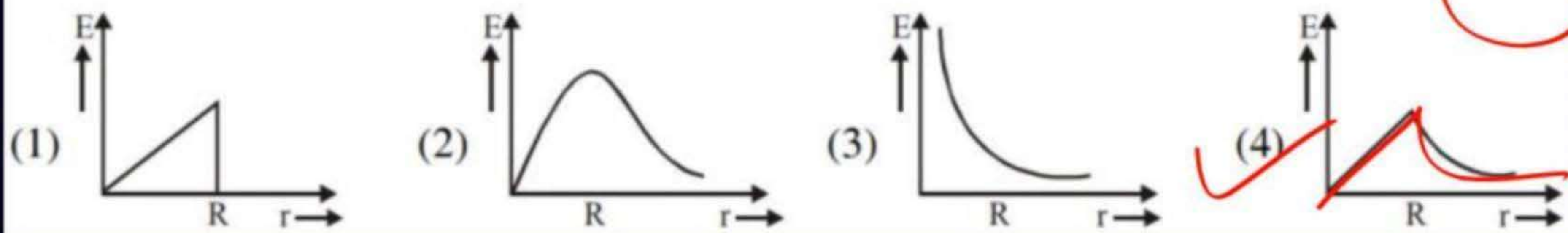
Column-I	Column-II
(A) Ring along its axis	(P) 
(B) Uniformly charged solid sphere	(Q)  $R/\sqrt{2}$
(C) Uniformly charged spherical shell	(R) 
(D) Combination of charge +Q and –Q at the perpendicular bisector	(S) 
	(T) 

Ans. (A)→(Q); (B)→(S); (C)→(R); (D)→(P)

QUESTION

In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as a function of distance from the centre. The graph which would correspond to the above will be :-

[AIEEE - 2012]



Ans : (4)

QUESTION

Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = Length, T = Time and A = electric current, then : [JEE-Main-2013]

(1) $[\epsilon_0] = [M^{-1} L^{-3} T^2 A]$

(2) $[\epsilon_0] = [M^{-1} L^{-3} T^4 A^2]$

(3) $[\epsilon_0] = [M^{-1} L^2 T^{-1} A^{-2}]$

(4) $[\epsilon_0] = [M^{-1} L^2 T^{-1} A]$

μ_0
ϵ_0

$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}$

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

$\epsilon_0 = \frac{q_1 q_2}{4\pi r^2 F}$

$\Delta q = i.\Delta t$

$= \frac{A^2 . T^2}{L^2 MLT^{-2}}$

Ans : (2)

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

QUESTION

JEE main Expected

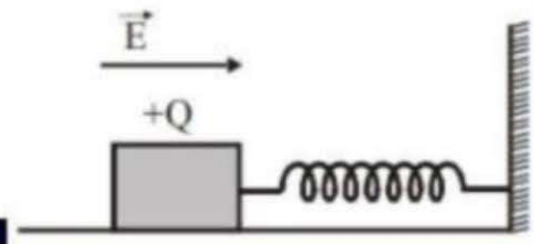
A wooden block performs SHM on a frictionless surface with frequency, ν_0. The block carries a charge $+Q$ on its surface. If now a uniform electric field $\vec{E}$ is switched-on as shown, then the SHM of the block will be :- **[IIT-JEE 2011]**

(A) of the same frequency and with shifted mean position

(B) of the same frequency and with the same mean position

(C) of changed frequency and with shifted mean position

(D) of changed frequency and with the same mean position



$T = 2\pi\sqrt{\frac{m}{k}}$

Ans : (A)

QUESTION

Consider a uniform spherical distirbution of radius R_1 centred at the origin O. In this distibution, a spherical cavity of radius R_2, centred at P with distance $OP = a = R_1 - R_2$ (see figure) is made. If the electric field inside the cavity at position $\vec{r}$ is $\vec{E}(\vec{r})$, then the correct statement(s) is(are) :

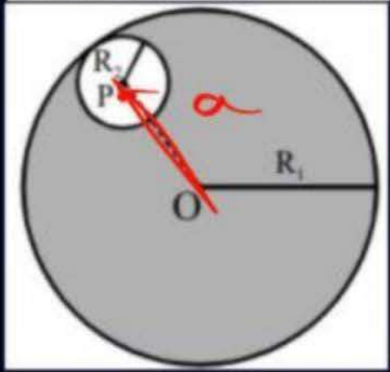
[JEE-Advance-2015]

(A) $\vec{E}$ is uniform, its magnitude is independent of R_2 but its direction depends on $\vec{r}$

(B) $\vec{E}$ is uniform, its magnitude depends on R_2 and its direction depends on $\vec{r}$

(C) $\vec{E}$ is uniform, its magnitude is independent of a but its direction depends on $\vec{a}$

(D) $\vec{E}$ is uniform and both its magnitude and direction depend on $\vec{a}$



$$E = \frac{\rho \overrightarrow{O_1O_2}}{3\epsilon_0} = \frac{\rho \vec{a}}{3\epsilon_0}$$

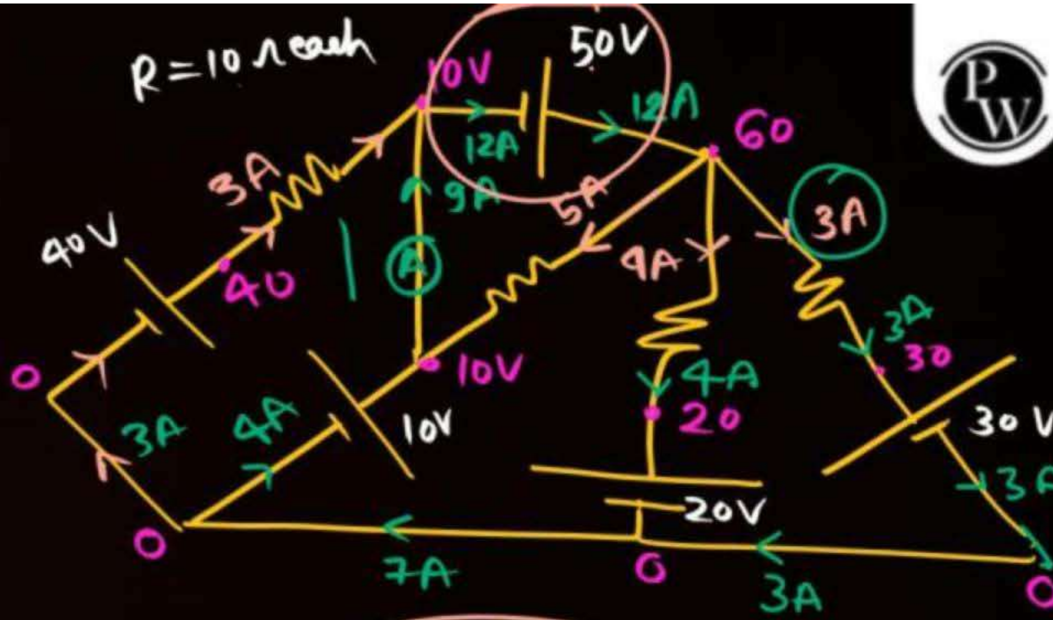
80

Ans : (D)

Current Electricity

- $V = iR$
- $i = v_d enA$ $\qquad v_d = \dfrac{i}{enA}$
- $\vec{J} = \sigma \vec{E}$ $\qquad i = \vec{J} \cdot \vec{A}$
- $i = \int \vec{J} \cdot d\vec{A}$

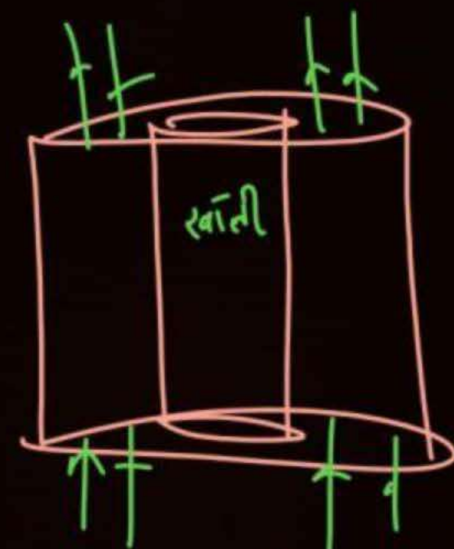
$$\text{Resist} = \rho \frac{l}{A}$$



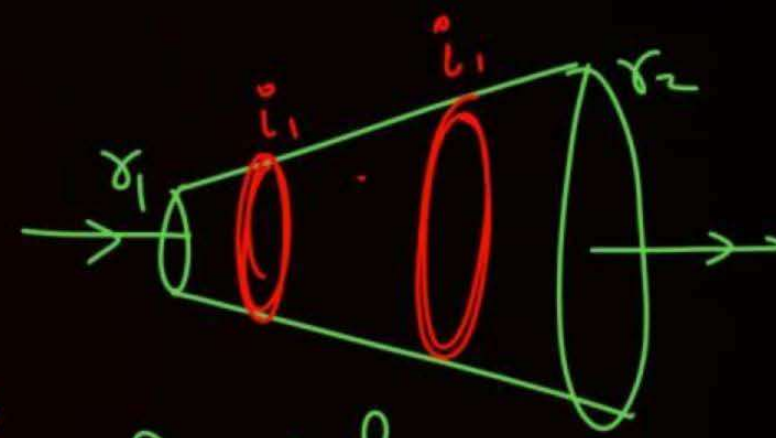
$$P = 50 \times 12$$

$i = V e n A$

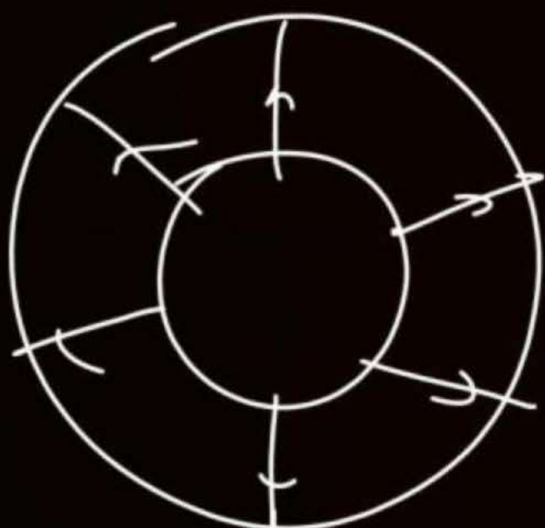
$$R = \rho \frac{l}{\pi r^2}$$

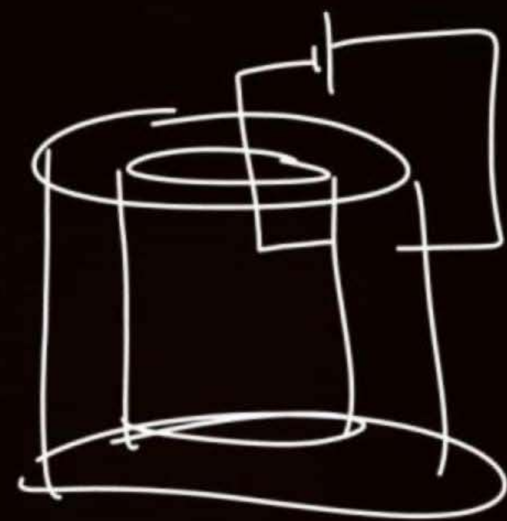


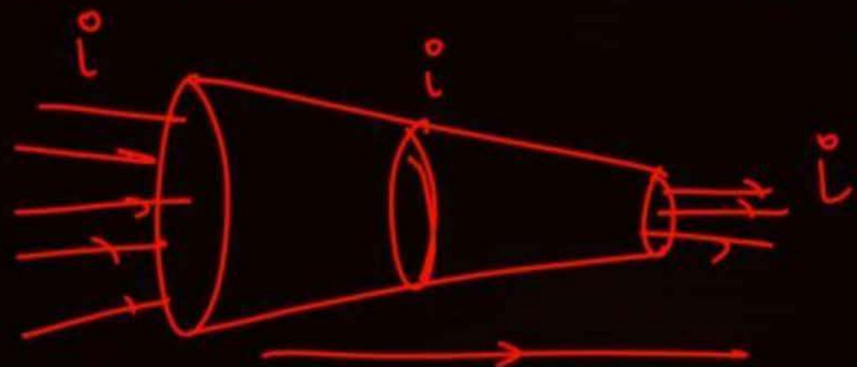
$$R = \rho \frac{l}{\pi(R_2^2 - R_1^2)}$$



$$R = \rho \frac{l}{\pi r_1 r_2}$$







$i = v e n A$

$i \longrightarrow$ same

$A \downarrow, v_d \uparrow$

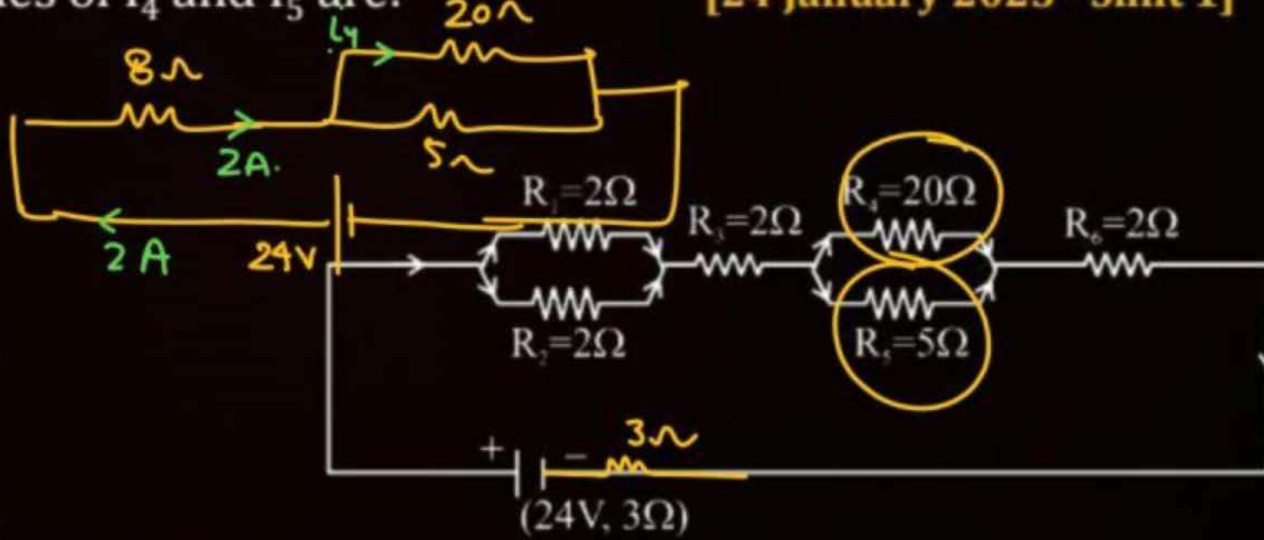
$\vec{J} = \sigma \vec{E}$

$\frac{i}{A} = \sigma E$

QUESTION

$R_{eq} = 8 + 4 = 12$ $\qquad i_4 = \frac{5}{25} \times 2$

As shown in the figure, a network of resistors is connected to a battery of 24V with an internal resistance of 3Ω. The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are: [24 January 2023 - Shift 1]



(1) $I_4 = \frac{8}{5}$ A and $I_5 = \frac{2}{5}$ A

(2) $I_4 = \frac{24}{5}$ A and $I_5 = \frac{6}{5}$ A

(3) $I_4 = \frac{6}{5}$ A and $I_5 = \frac{24}{5}$ A

(4) $I_4 = \frac{2}{5}$ A and $I_5 = \frac{8}{5}$ A

$2 - \frac{2}{5} = 8/5$

Ans : (4)

QUESTION

formula

A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of the conductor is $n \times 10^{-3}\,\Omega$. If the resistivity of the material is $2.4 \times 10^{-8}\,\Omega m$. The value of n is

$r_1 = 2\,mm$

$r_2 = 4\,mm$

[24 January 2023 - Shift 1]

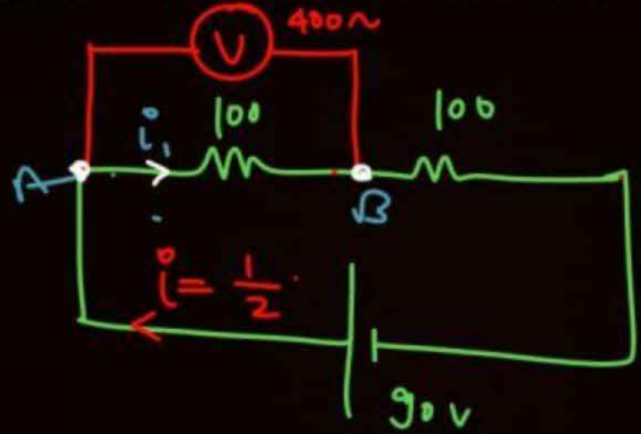
Ans : (2)

QUESTION

$\frac{40000}{500} = 80$

A cell of emf 90V is connected across series combination of two resistors each of 100 Ω resistance. A voltmeter of resistance 400 Ω is used to measure the potential difference will be:

[24 January 2023 - Shift 2]



(1) 40 V

(2) 45 V

(3) 80 V

(4) 90 V

$R_{eq} = 180$

$90 = i \times 180$

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

$i_1 = \frac{400}{500} \times \frac{1}{2} = \frac{2}{5}$

$100 \times \frac{2}{5} = 40$

Ans : (1)

QUESTION

If a copper wire is stretched to increase its length by 20% . The percentage increase in resistance of the wire is %.

[24 January 2023 - Shift 2]

$$R = \rho \frac{l}{A} = \rho \frac{l^2}{Al} \qquad l_1 = 10 \longrightarrow l_f = 12$$

$$R \propto l^2 \qquad \frac{R_2}{R_1} = \frac{l_2^2}{l_1^2} = \frac{144}{100}$$

$$\frac{R_2}{R_1} - 1 = \frac{144}{100} - 1 \qquad \frac{\Delta R}{R_1} \times 100 = 44\%$$

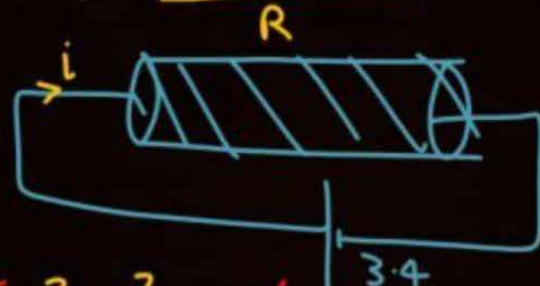
$$\frac{R_2 - R_1}{R_1} = \frac{\Delta R}{R_1} = \frac{44}{100}$$

Ans : (44)

QUESTION

A uniform metallic wire carries a current 2 A. When 3.4 V battery is connected across it. The mass of uniform metallic wire is 8.92×10^{-3}kg. Density is $8.92 \times 10^3 \text{kg/m}^3$ and resistivity is $1.7 \times 10^{-8}\,\Omega$ - m. The length of wire is :

[25 January 2023 - Shift 1]



(1) $l = 6.8$ m

(2) $l = 10$ m

(3) $l = 5$ m

(4) $l = 100$ m

$3.4 = 2 \times R$

$R = 1.7 = \rho \frac{l}{A} = \rho \frac{l^2}{A l}$

$1.7 = \rho \frac{l^2}{(M/\text{density})}$

$1.7 = \frac{\rho \text{ density}}{\text{mass}} l^2$

$\cancel{1.7} = \frac{\cancel{8.92} \times 10^3 \times l^2 \times \cancel{1.7} \times 10^{-8}}{\cancel{8.92} \times 10^{-3}}$

$l^2 = 100$

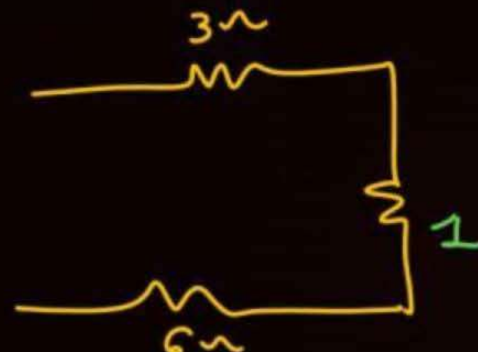
$l = 10$

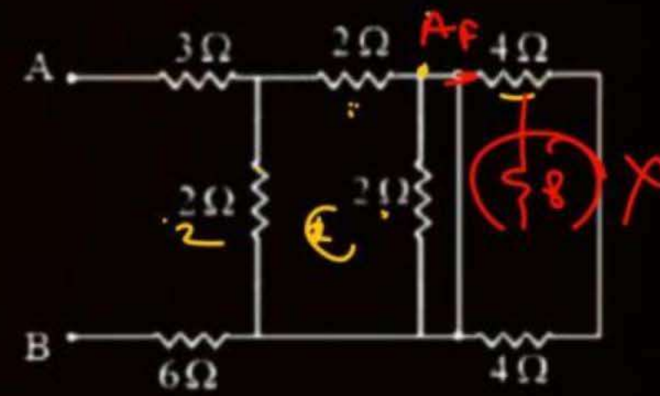
Ans : (2)

QUESTION

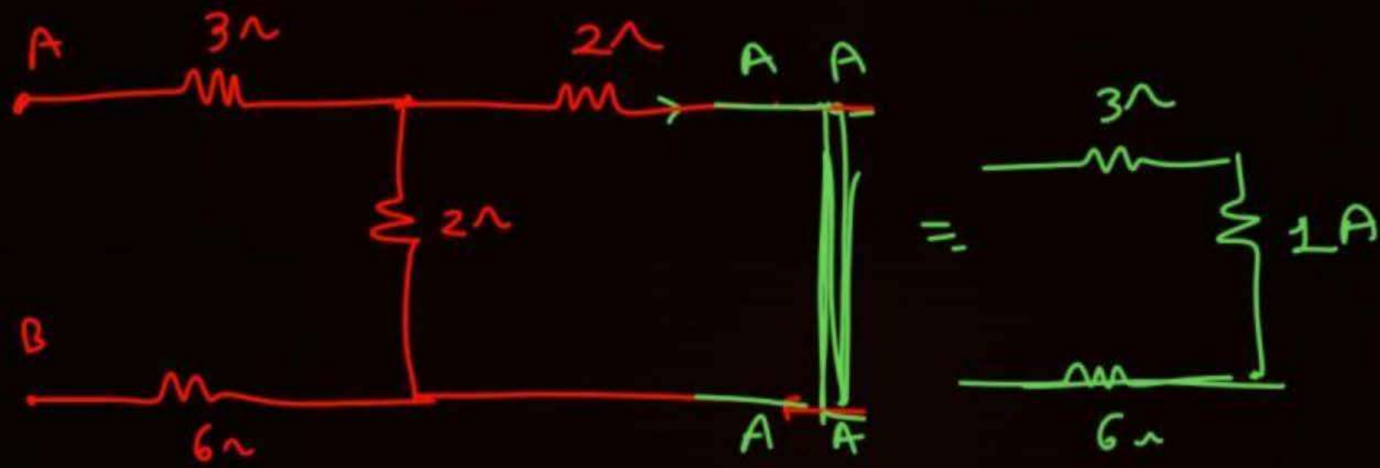
In the given circuit, the equivalent resistance between the terminal A and B is __10__ Ω.

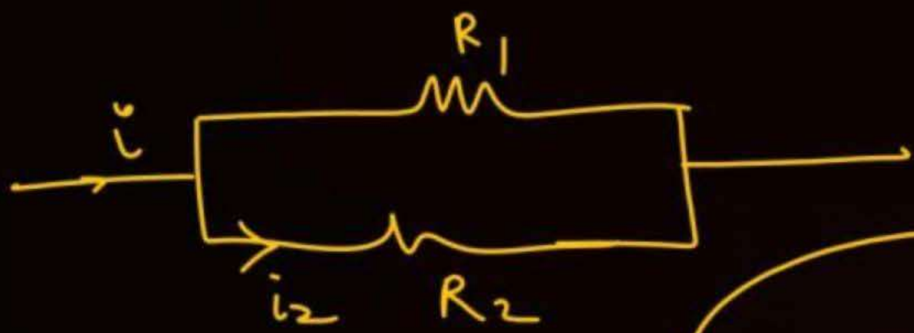
[25 January 2023 - Shift 1]





Ans : (10)


A
3Ω
2Ω
A
A
2Ω
B
6Ω
A
A
=
3Ω
1A
6Ω



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

$$i_2 = \frac{R_1}{R_1 + R_2} \times i$$

QUESTION

The resistance of a wire is 5 Ω. It's new resistance in ohm if stretched to 5 times of it's original length will be :

[25 January 2023 - Shift 2]

(1) 625

(2) 5

(3) 125

(4) 25

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

25 times

$R_i = 5\Omega \longrightarrow R_f = 125$

Ans : (3)

QUESTION

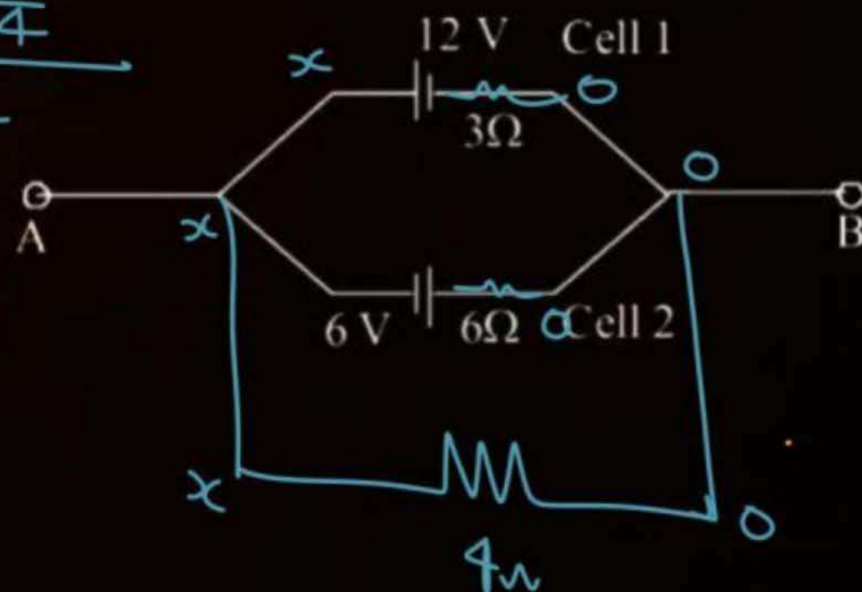
$x = \frac{3\times4}{3} = 4$ $\quad \frac{2}{2\times2} + \frac{1}{4}$

Two cells are connected between points A and B as shown. Cell 1 has emf of 12 V and internal resistance of 3 Ω. Cell 2 has emf of 6 V and internal resistance of 6 Ω. An external resistor R of 4 Ω is connected across A and B. The current flowing through R will be______.

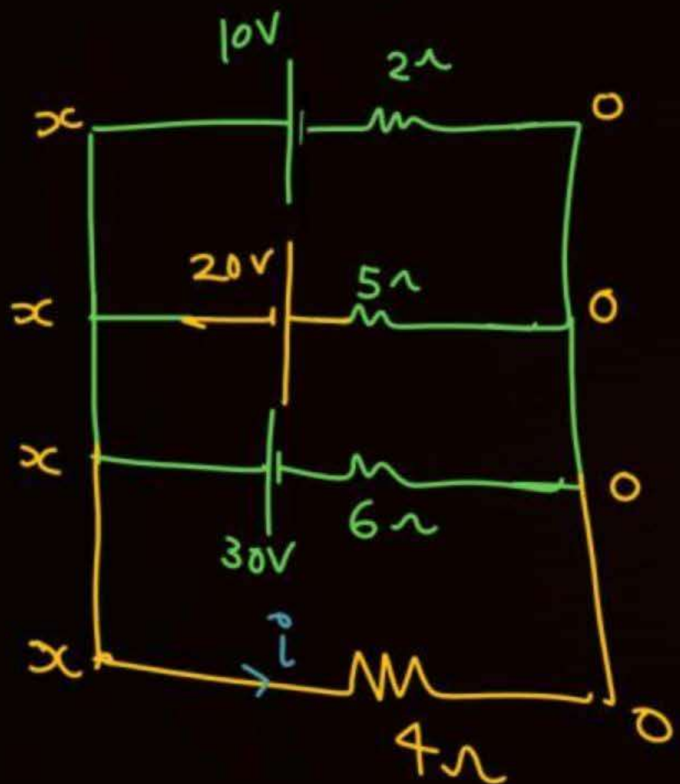
[25 January 2023 - Shift 2]

$$x = \frac{\frac{12}{3} - \frac{6}{6} + \frac{0}{4}}{\frac{1}{3} + \frac{1}{6} + \frac{1}{4}}$$

$$i = \frac{x-0}{4} = \frac{4-0}{4} = 1$$

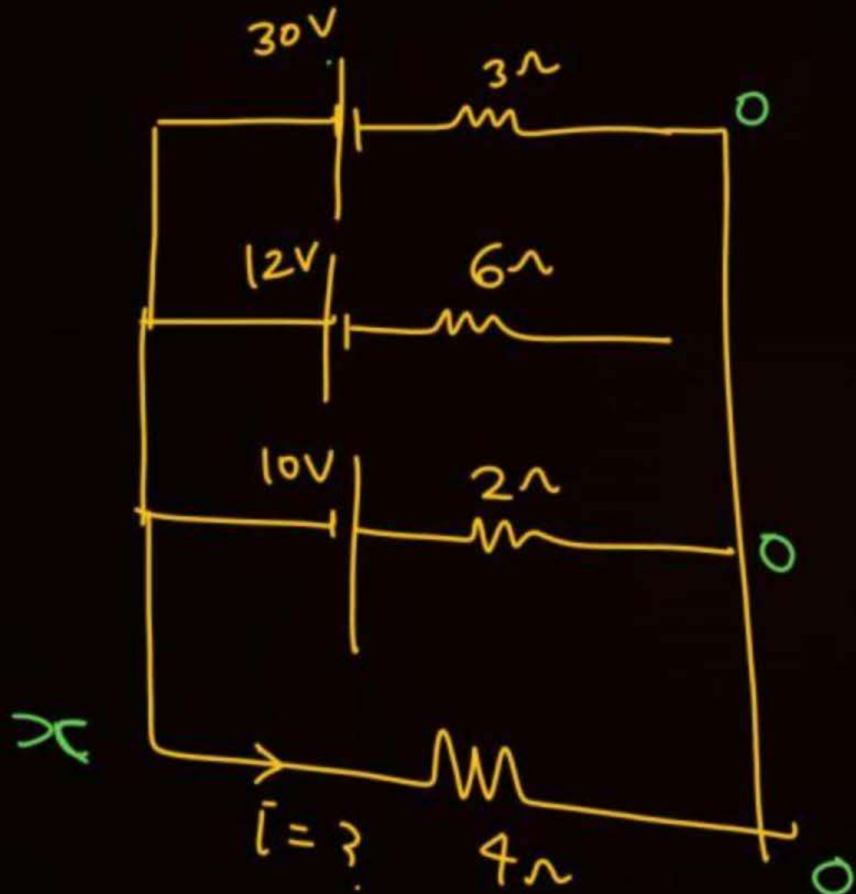


Ans : (1)



$$x = \frac{\frac{10}{2} - \frac{20}{5} + \frac{30}{6} + \frac{0}{4}}{\frac{1}{2} + \frac{1}{5} + \frac{1}{6} + \frac{1}{4}}$$

$$i = \frac{x - 0}{4}$$



$$x = \frac{10+2-5+0}{\frac{1}{3}+\frac{1}{6}+\frac{1}{2}+\frac{1}{4}} = \frac{7}{1+\frac{1}{4}} = \frac{7\times 4}{5}$$

$$i = \frac{x-0}{4} = \frac{28}{5\times 4} = \frac{7}{5}$$

QUESTION

The charge flowing in a conductor changes with time as $Q(t) = \alpha t - \beta t^2 + \gamma t^3$. Where α, β and γ are constants. Minimum value of current is: **[30 January 2023 - Shift 1]**

$i = \alpha - 2\beta t + 3\gamma t^2$

min

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

(1) $\alpha - \frac{3\beta^2}{\gamma}$

(2) $\alpha - \frac{\gamma^2}{3\beta}$

(3) $\beta - \frac{\alpha^2}{3\gamma}$

(4) $\alpha - \frac{\beta^2}{3\gamma}$

Ans : (4)

QUESTION

$6y - 2x = -6$
$2x - y = 6$

$y = 0,\ x = 3$

In the following circuit, the magnitude of current I_1, is ________ A.

[30 January 2023 - Shift 1]

$i_1 = 1.5$

$\frac{y-2}{1} + \frac{y+5-x}{1} + \frac{y-0}{1} = 0$

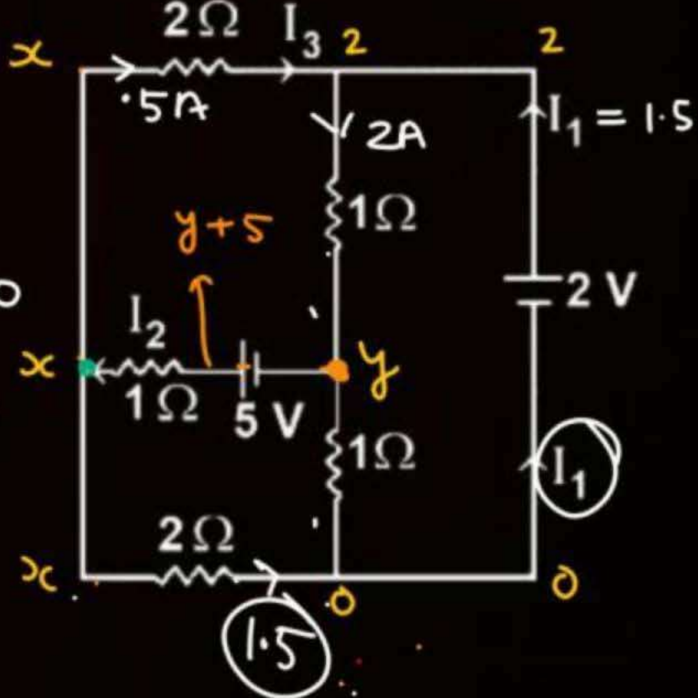
$\boxed{3y - x + 3 = 0}$

$\frac{x-2}{2} + \frac{x-(y+5)}{1} + \frac{x-0}{2} = 0$

$x - 2 + 2x - 2y - 10 + x = 0$

$4x - 2y = 12$

$\boxed{2x - y = 6}$



Ans : (6)

QUESTION

The equivalent resistance between A and B is .

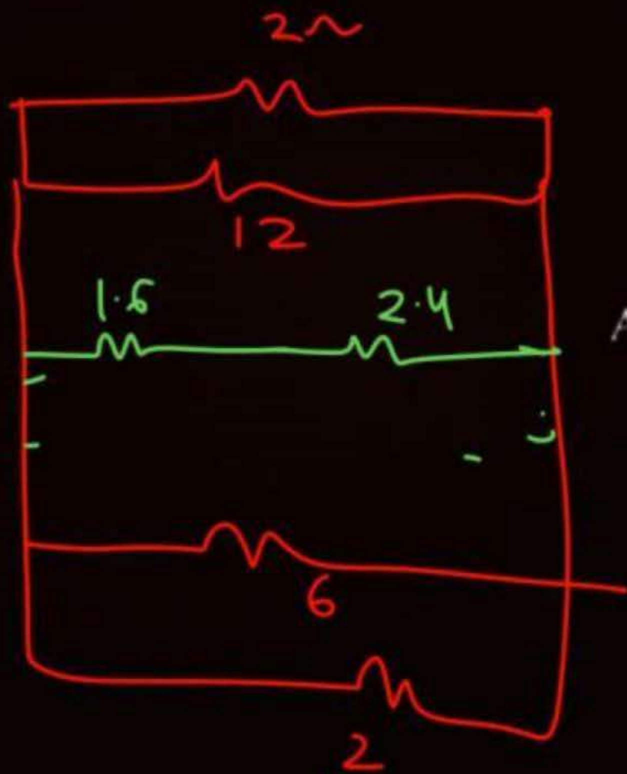
[30 January 2023 - Shift 2]

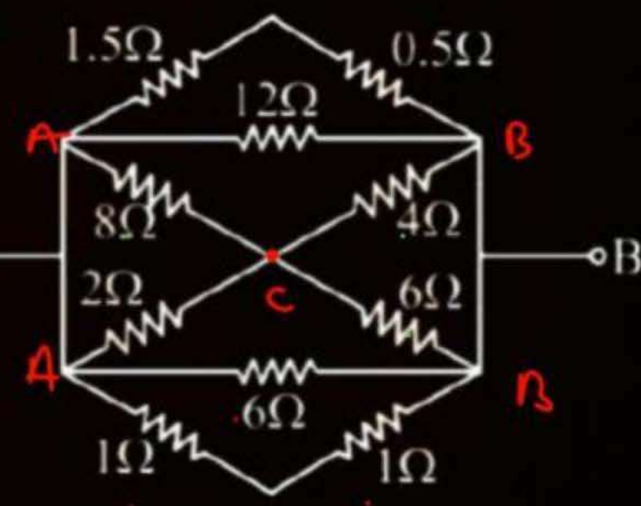
(1) $\frac{2}{3}\Omega$

(2) $\frac{1}{2}\Omega$

(3) $\frac{3}{2}\Omega$

(4) $\frac{1}{3}\Omega$





Ans : (1)

QUESTION

If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is ______.

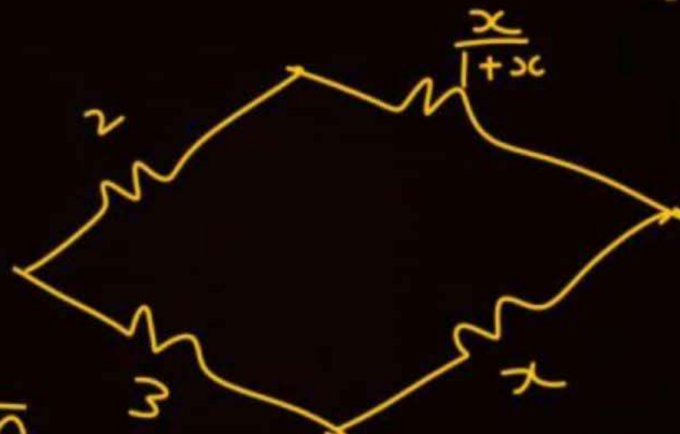
[30 January 2023 - Shift 2]

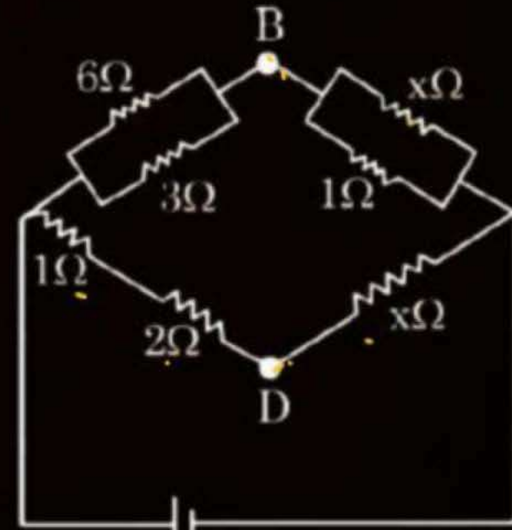
$$\frac{2(1+x)}{\cancel{x}} = \frac{3}{\cancel{x}}$$

$$2+2x=3$$

$$x=\frac{1}{2}=\frac{1}{n}$$

$$n=2$$





Ans : (2)

QUESTION

The drift velocity of electrons for a conductor connected in an electrical circuit is V_d. The conductor in now replaced by another conductor with same material and same length but double the area of cross section. The applied voltage remains same. The new drift velocity of electrons will be

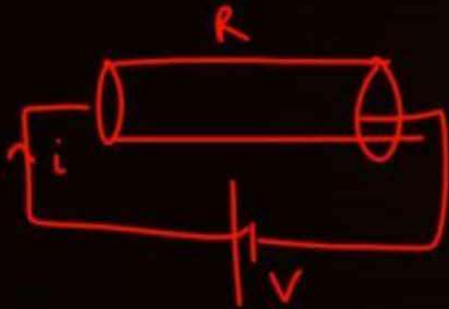
[31 January 2023 - Shift 1]

(1) V_d

(2) $\frac{V_d}{2}$

(3) $\frac{V_d}{4}$

(4) $2V_d$



$$i = \frac{V}{R} = V_d e n A$$

$$V_d = \frac{V}{\frac{\rho \ell}{\cancel{A}} e n \cancel{A}} = \frac{V}{\rho \ell e n}$$

Ans : (1)

QUESTION

Common qun — 3-4 बार

The H amount of thermal energy is developed by a resistor in 10 s when a current of 4A is passed through it. If the current is increased to 16A, the thermal energy developed by the resistor in 10 s will be: [31 January 2023 - Shift 2]

$H = i^2Rt$ → 16 गुना

$i \longrightarrow$ 4 गुना

$t \longrightarrow$ Sam

(1) H

(2) 16H

(3) $\frac{H}{4}$

(4) 4H

Ans : (2)

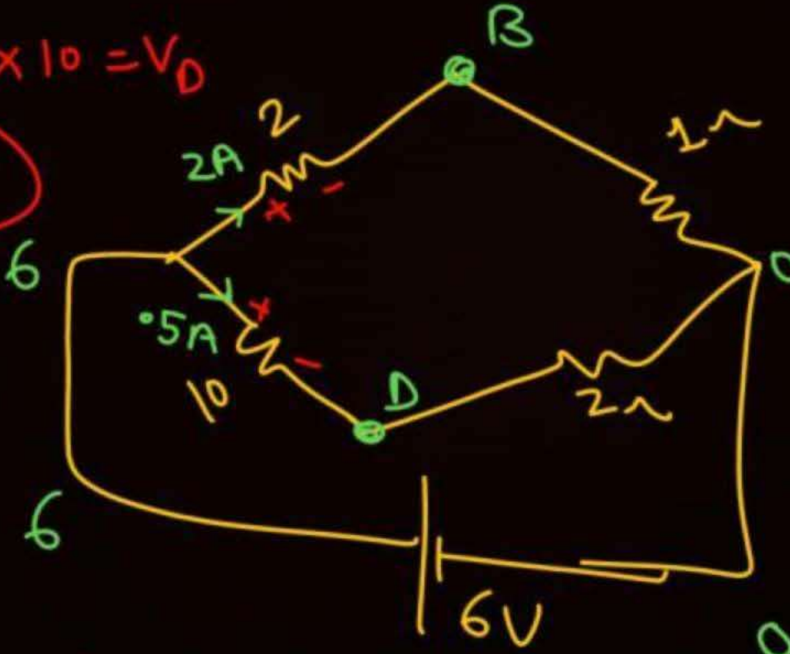
QUESTION

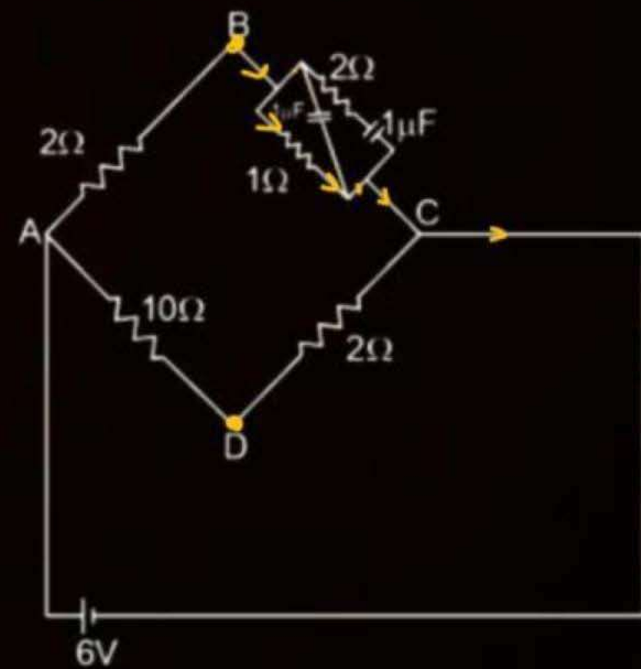
For the given circuit, in the steady state, $|V_B - V_D| =$ ________ V.

[31 January 2023 - Shift 2]

$V_B + 4 - .5 \times 10 = V_D$

$V_B - V_D = 1$



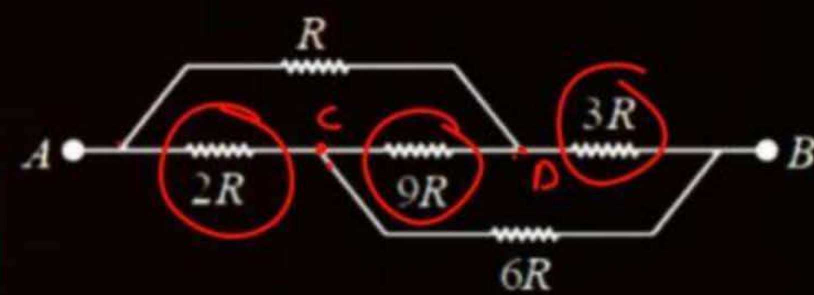


Ans : (1)

QUESTION

The equivalent resistance between A and B of the network shown in figure:

[01 February 2023 - Shift 1]

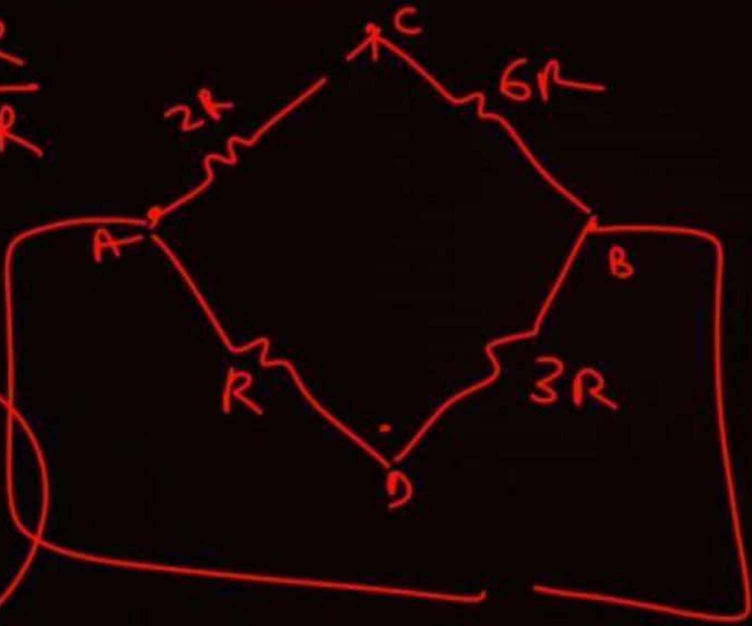


$$\frac{8R \times 4R}{8R+4R}$$

$$= \frac{32R}{12}$$

$$= \frac{8}{3}R$$

$$= 2.66R$$



Ans : (

QUESTION

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : For measuring the potential difference across a resistance of 600 Ω, the voltmeter with resistance 1000 Ω will be preferred over voltmeter with resistance 4000 Ω.

Reason R : Voltmeter with higher resistance will draw smaller current than voltmeter with lower resistance.

In the light of the above statements, choose the **most appropriate** answer from the options given below. [01 February 2023 - Shift 2]

1. A is not correct but R is correct
2. Both A and R are correct and R is the correct explanation of A
3. Both A and R are correct but R is not the correct explanation of A
4. A is correct but R is not correct

Ans : (1)

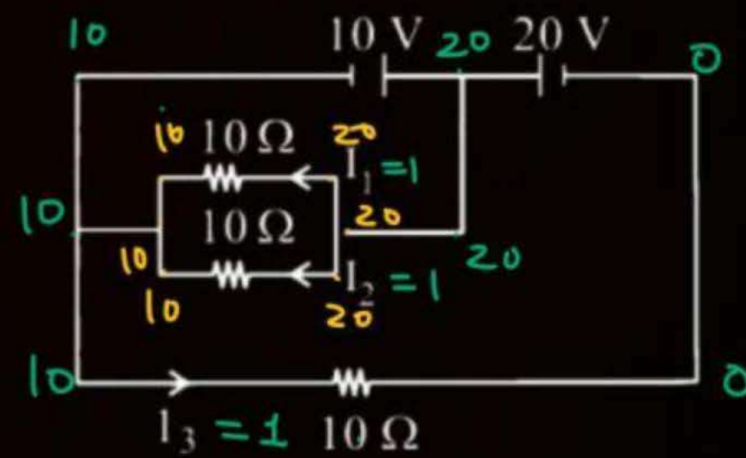
QUESTION

In the given circuit the value of $\left|\frac{I_1+I_3}{I_2}\right|$ is:

[01 February 2023 - Shift 2]

$i_3 = 1$

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



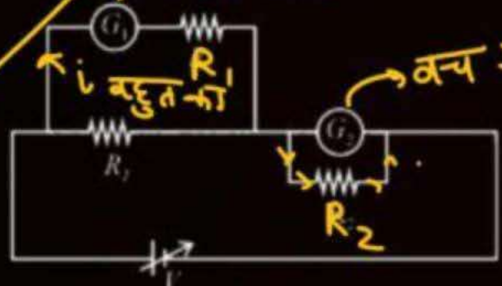
Ans : (2)

QUESTION JA Jm copy

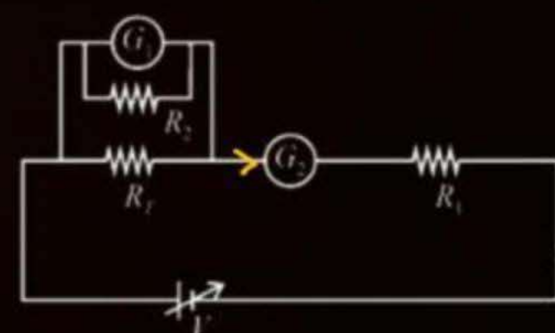
A student is provided with a variable voltage source V, a test resistor $R_T = 10\ \Omega$, two identical galvanometers G_1 and G_2 and two additional resistors, $R_1 = 10\ M\Omega$ and $R_2 = 0.001\ \Omega$. For conducting an experiment to verify ohm's law, the most suitable circuit is:

[06 April 2023 - Shift 2]

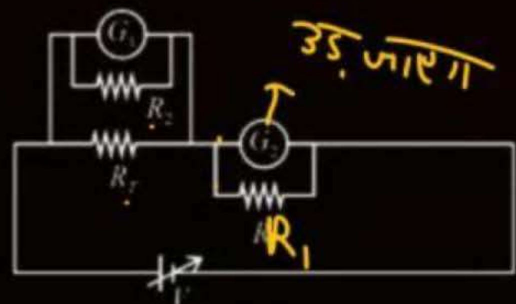
(1)



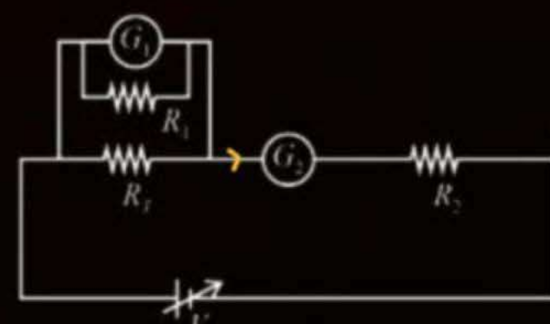
(2)



(3)



(4)



Ans : (1)

QUESTION

Figure shows a part of an electric circuit. The potentials at points a, b and c are 30 V, 12 V and 2 V respectively. The current through the 20Ω resistor will be,

[06 April 2023 - Shift 2]

(1) 1.0 A

(2) 0.4 A

(3) 0.6 A

(4) 0.2 A

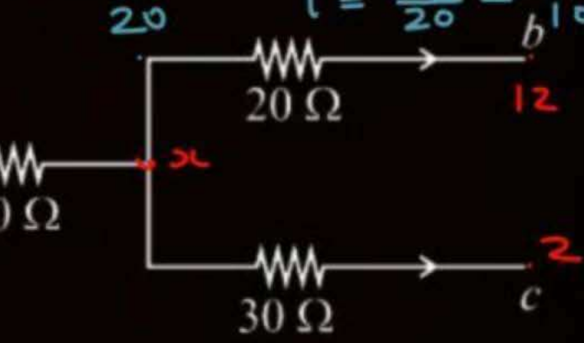
$$\frac{x-30}{10}+\frac{x-12}{20}+\frac{x-2}{30}=0$$

$$6x-180+3x-36+2x-4=0$$

$$11x=220$$

$$x=20$$

$$i=\frac{8}{20}=\frac{4}{10}$$



Ans : (2)

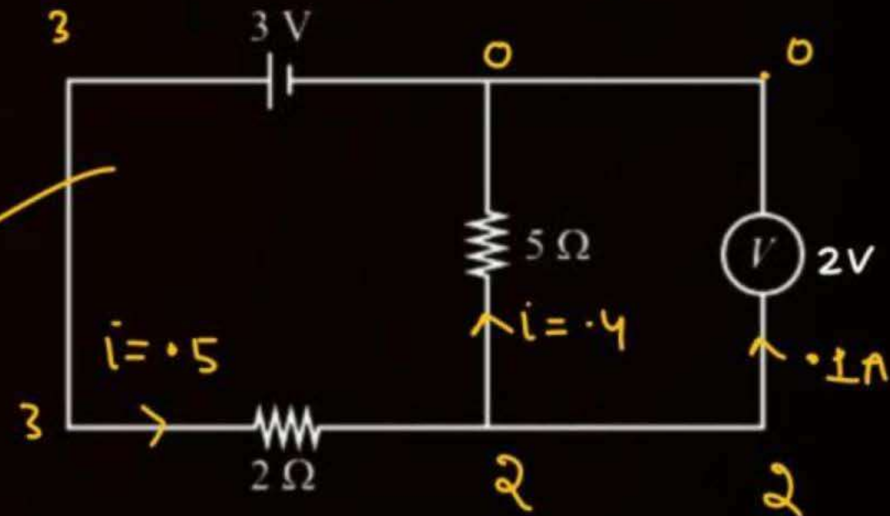
QUESTION

As shown in the figure the voltmeter reads 2 V across 5Ω resistor. The resistance of the voltmeter is_____ Ω

[06 April 2023 - Shift 2]

$2 = \cdot 1 \times R$

$R = 20$



Ans : (20)

QUESTION

$\frac{8}{10}$

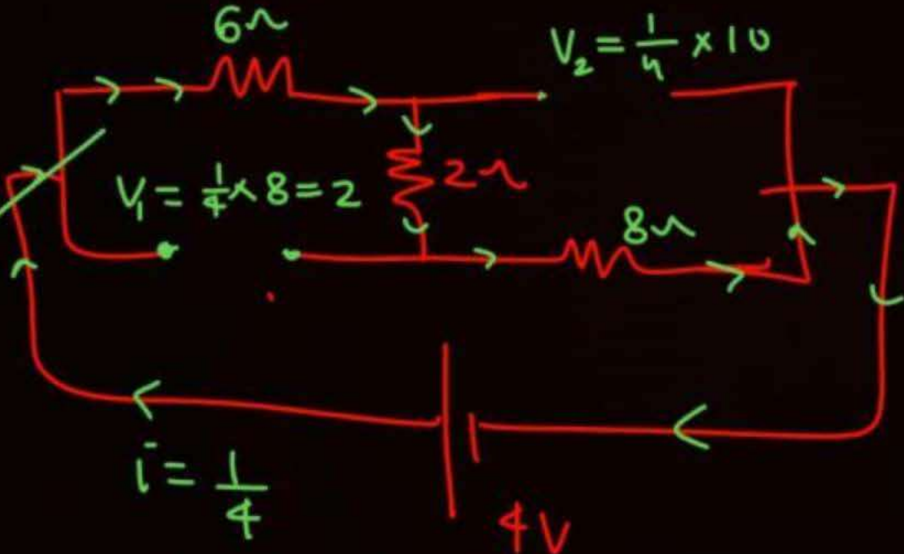
In this figure the resistance of the coil of galvanometer G is 2Ω. The emf of the cell is 4V. The ratio of potential difference across C_1 and C_2 is **[08 April 2023 - Shift 1]**

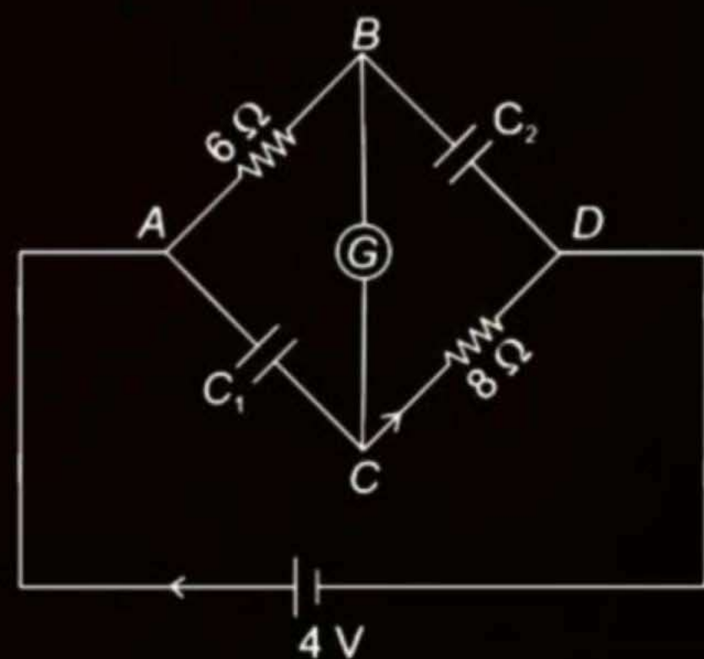
(1) 1

(2) $\frac{4}{5}$

(3) $\frac{5}{4}$

(4) $\frac{3}{4}$





Ans : (2)

QUESTION

A current 2A of flows through a wire of cross-sectional area 25.0 mm^2. The number of free electrons in a cubic meter are 2.0×10^{28}. The drift velocity of the electrons is ______ $\times 10^{-6}$ ms^{-1} 10^{-6}
(given, charge on electron = 1.6×10^{-19}C). [08 April 2023 - Shift 1]

$$i = v e n A$$

$$v = \frac{i}{enA} = \frac{\cancel{2}}{1.6\times10^{-19} \times \cancel{2}\times10^{28} \times 25\times10^{-6}}$$

$$= \frac{1000 \times 10^{-3} \times 10^{-3}}{40}$$

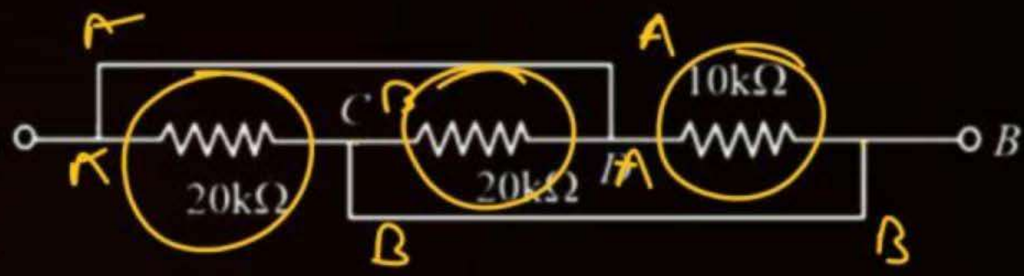
$$= \underline{\underline{25}} \times 10^{-6}$$

Ans : (25)

QUESTION

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

[08 April 2023 - Shift 2]



(1) $10\ k\Omega$

(2) $5\ k\Omega$

(3) $20\ k\Omega$

(4) $30\ k\Omega$

$$\frac{1}{R_{eq}} = \frac{1}{20} + \frac{1}{20} + \frac{1}{10}$$

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

Ans : (2)

QUESTION

The number density of free electrons in copper is nearly 8×10^{28} m^{-3}. A copper wire has its area of cross-section $= 2 \times 10^{-6} m^2$ and is carrying a current of 3.2 A. The drift speed of the electrons is ______ $\times 10^{-6}$ ms^{-1}.

[08 April 2023 - Shift 2]

$$i = venA$$

$$v = \frac{i}{enA} = \frac{3.2}{1.6 \times 10^{-19} \times 8 \times 10^{28} \times 2 \times 10^{-6}}$$

Ans : (125)

QUESTION

The equivalent resistance of the circuit shown below between points a and b is :

[10 April 2023 - Shift 1]

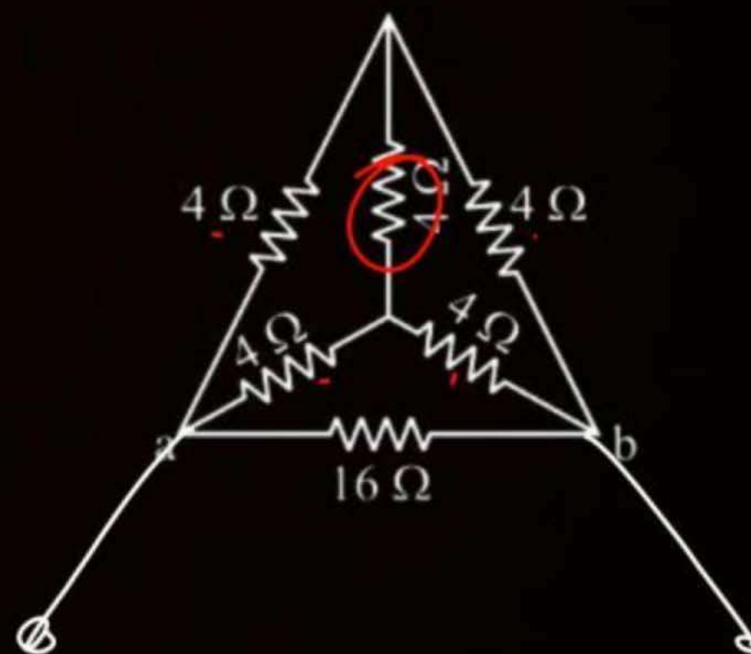
$$\frac{16\times 4}{20}$$

(1) $16\,\Omega$

(2) $3.2\,\Omega$

(3) $24\,\Omega$

(4) $20\,\Omega$



Ans : (2)

QUESTION

10 resistors each of resistance 10Ω can be connected in such as to get maximum and minimum equivalent resistance. The ratio of maximum and minimum equivalent resistance will be______.

[10 April 2023 - Shift 1]

$$\frac{100}{1} = \underline{100}$$

Ans : (100)

QUESTION

Two identical heater filaments are connected first in parallel and then in series. At the same applied voltage, the ratio of heat produced in same time for parallel to series will be:

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

[11 April 2023 - Shift 1]

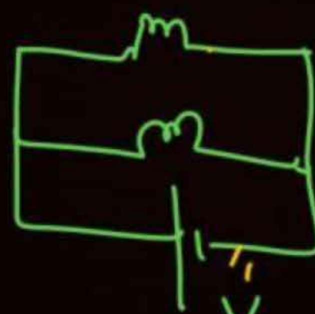
(1) 1 : 4

(2) 4 : 1

(3) 2 : 1

(4) 1 : 2

parallel =



$H_1 = \frac{V^2}{R/2} t = \frac{2V^2 t}{R}$

$H_2 = \frac{V^2}{2R} t$

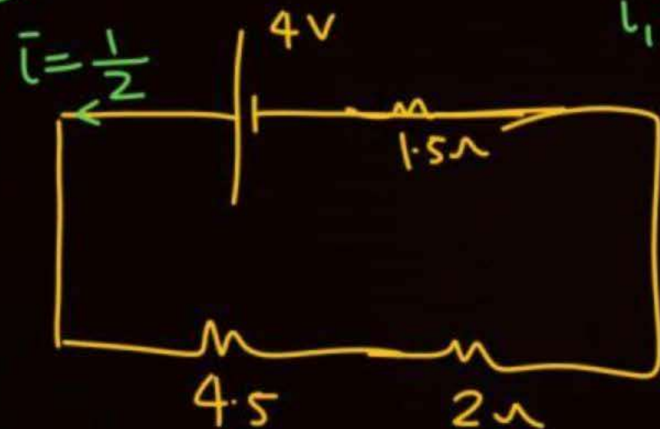
Ans : (2)

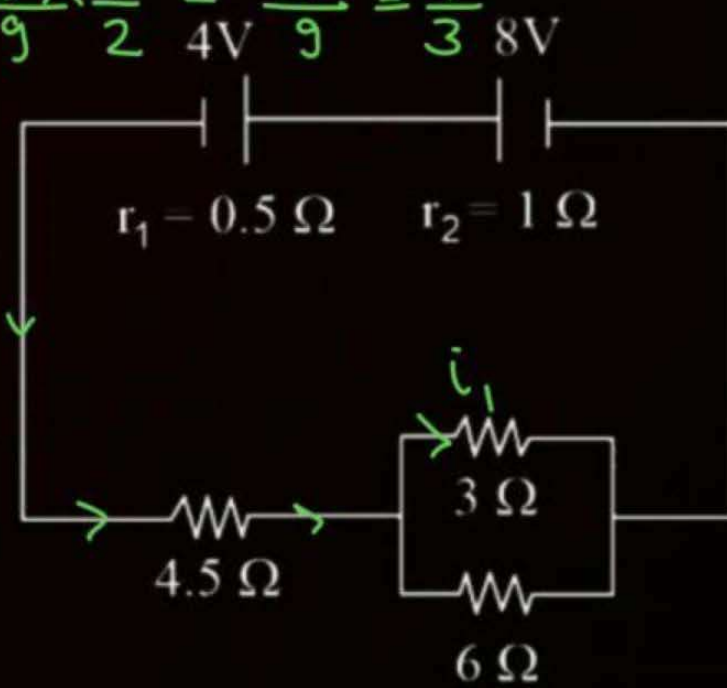
QUESTION

In the circuit diagram shown in figure given below, the current flowing through resistance 3Ω is $\frac{x}{3}$A. The value of x is ____ $\frac{1}{3} = \frac{x}{3}$ $x = 1$

[11 April 2023 - Shift 1]

$i_1 = \frac{6}{9} \times \frac{1}{2} = \frac{3}{9} = \frac{1}{3}$





Ans : (1)

QUESTION

The current flowing through R_2 is :

[11 April 2023 - Shift 2]

(1) $\frac{2}{3}$ A

(2) $\frac{1}{2}$ A

(3) $\frac{1}{3}$ A

(4) $\frac{1}{4}$ A

Ans : (3)

QUESTION

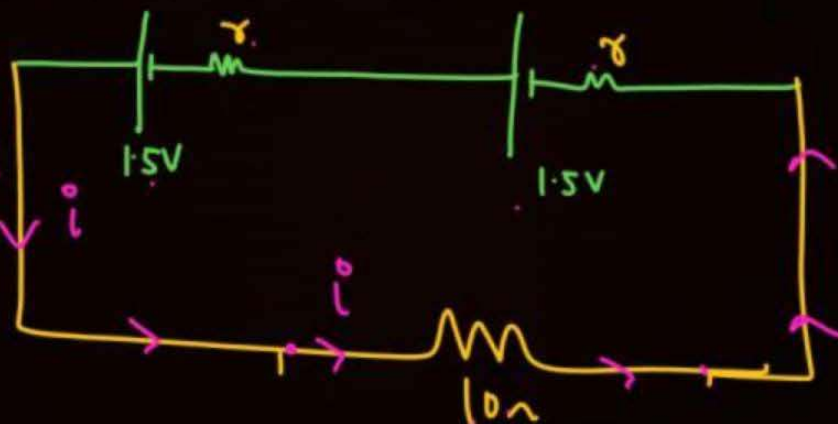
Two identical cells each of emf 1.5 V are connected in series across a 10 Ω resistance. An ideal voltmeter connected across 10 Ω resistance reads 1.5 V. The internal resistance of each cell is ______ Ω

[11 April 2023 - Shift 2]

$$i = \frac{3}{2r+10} = \frac{15}{100}$$

$$300 = 30r + 150$$

$$r = 5$$



$$1.5 = iR$$

$$1.5 = i \times 10$$

$$i = .15$$

Ans : (5)

QUESTION

$l/4$

A wire of resistance 160 Ω is melted and drawn in a wire of one-fourth of its length. The new resistance of the wire will be. **[12 April 2023 - Shift 1]**

(1) 16 Ω

(2) 10 Ω

(3) 640 Ω

(4) 40 Ω

$$R = \rho \frac{l \, l}{A \, l} = \rho \frac{l^2}{\text{Vol}^n}$$

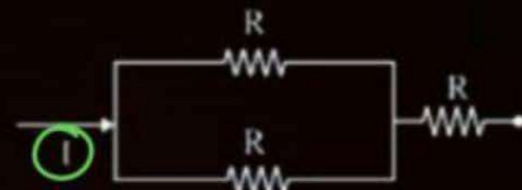
$$\frac{160}{16} = 10$$

Ans : (2)

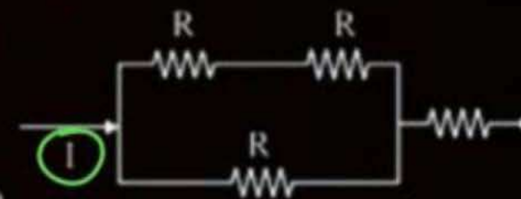
QUESTION

Different combination of 3 resistors of equal resistance R are shown in the figures. The increasing order for power dissipation is: **[13 April 2023 - Shift 1]**

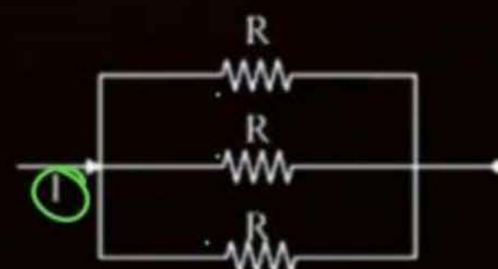
$P = i^2 R_{eq}$



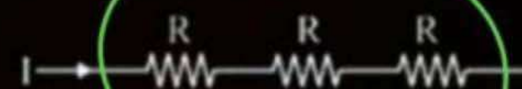
(A)



(B)



(C)



(D)

(1) $P_B < P_C < P_D < P_A$

(2) $P_C < P_D < P_A < P_B$

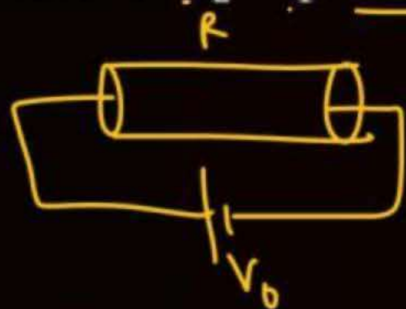
(3) $P_C < P_B < P_A < P_D$

(4) $P_A < P_B < P_C < P_D$

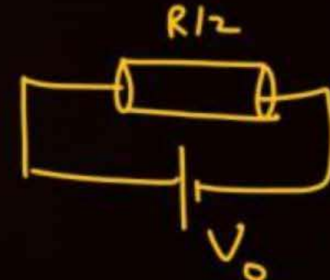
Ans : (3)

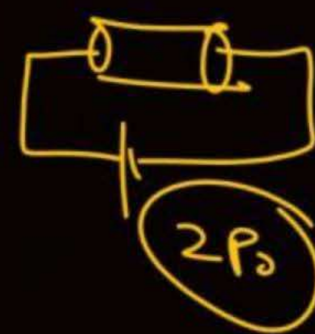
QUESTION

A potential V_0 is applied across a uniform wire of resistance R. The power dissipation is P_1. The wire is then cut into two equal halves and a potential of V_0 is applied across the length of each half. The total power dissipation across two wires is P_2. The ratio of $P_2 : P_1$ is $\sqrt{x} : 1$. The value of x is ______. **[13 April 2023 - Shift 1]**



$P_1 = \frac{V_0^2}{R} = P_0$





$P = 2P_0$

$$\frac{4P_0}{P_0} = 4 = \frac{\sqrt{x}}{1}$$

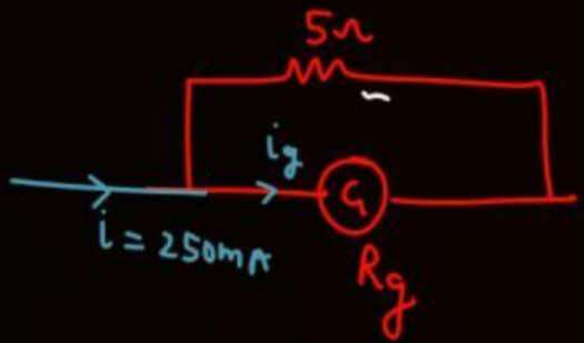
Ans : (16)

QUESTION

$$R_g = \frac{47500\cancel{0}}{950\cancel{0}} = 50$$

When a resistance of 5 Ω is shunted with a moving coil galvanometer, it shows a full scale deflection for a current of 250 mA, however when 1050 Ω resistance is connected with it in series, it gives full scale deflection for 25 volt. The resistance of galvanometer is ______ Ω.

[13 April 2023 - Shift 1]



$$i_g = \frac{5}{5+R_g} \times 250\times10^{-3}$$

$$V_{AB} = 25 = i_g\left(R_g + 1050\right)$$

$$\cancel{25} = \frac{5\times\cancel{250}^{10}\times10^{-3}}{5+R_g}\left(R_g+1050\right)$$

$$1000(5+R_g) = 50R_g + 50\times1050$$

$$5000 + 950R_g = 52500$$

Ans : (50)

QUESTION

Given below are two statements: $2\Omega \quad 3\Omega \quad 4\Omega \equiv 9\Omega$

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

Statement II : The resistivity of the material is independent of temperature. In the light of the above statements, choose the correct answer from the options given below:

$\rho = \rho_0(1 + \alpha \Delta T)$

[15 April 2023 - Shift 1]

(1) Both Statement I and Statement II are false

(2) Both Statement I and Statement II are true

(3) Statement I is true but Statement II is false

(4) Statement I is false but Statement II is true

Ans : (1)

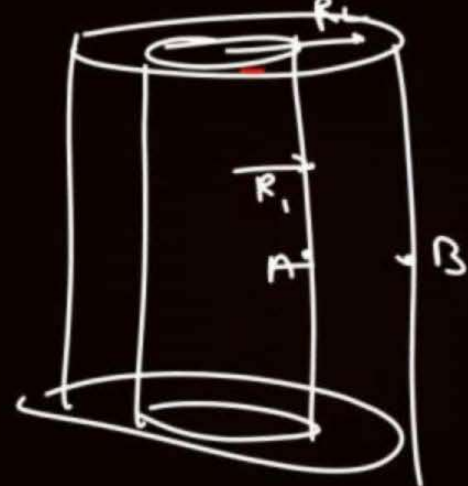
QUESTION

A network of four resistances is connected to 9 V battery, as shown in figure. The magnitude of voltage difference between the points A and B is ______ V

[15 April 2023 - Shift 1]

$$V_A + 3 - 6 = V_B$$

Ans : (3)



$$\int dR = \int_{R_2}^{R_2} \rho \times \frac{dx}{2\pi x l}$$

hollow
shere

$$\int dR = \int \frac{\rho \, dr}{4\pi r^2}$$

QUESTION

The value of current i_1 flowing from A to C in the circuit diagram is:

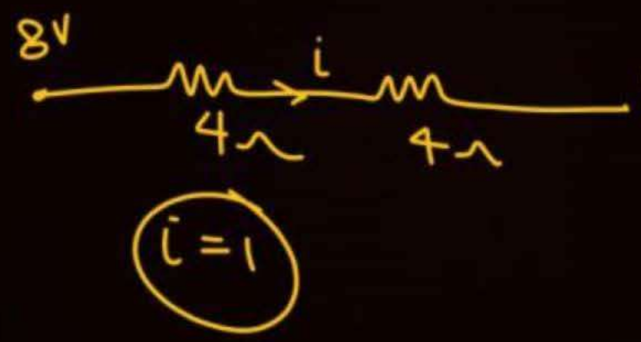
[JEE Main-2020]

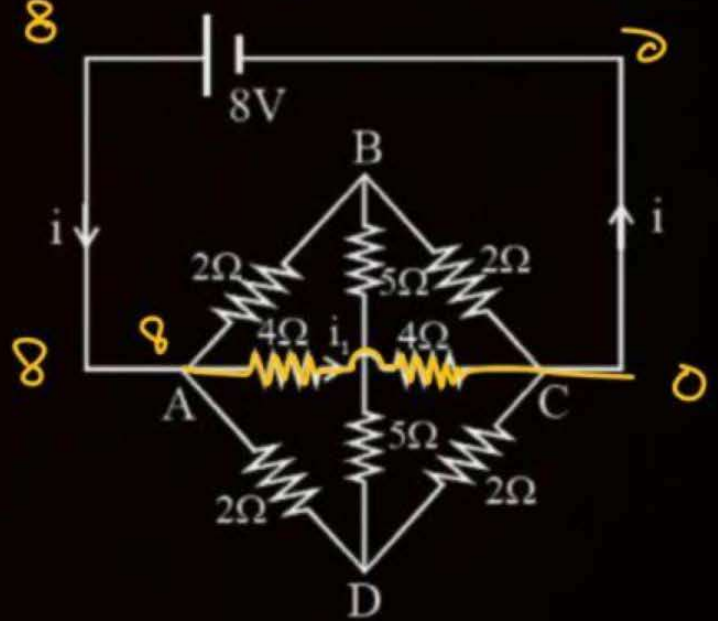
(1) 5 A

(2) 2 A

(3) 4 A

(4) 1 A

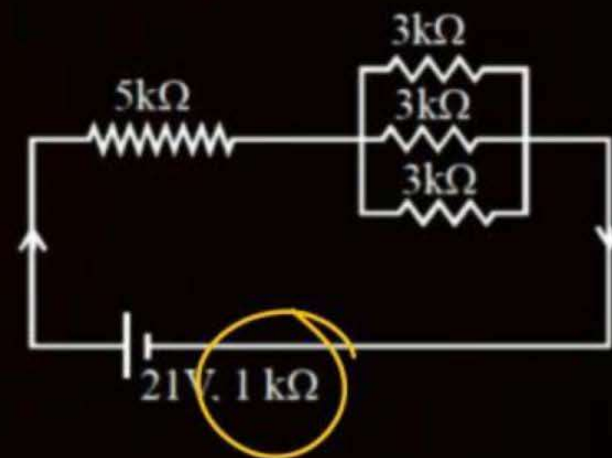




Ans :

QUESTION

In the figure given, the electric current flowing through the 5 kΩ resistor is 'x' mA. The value of x to the nearest integer is ______. [JEE Main-2021]



Ans : (3)

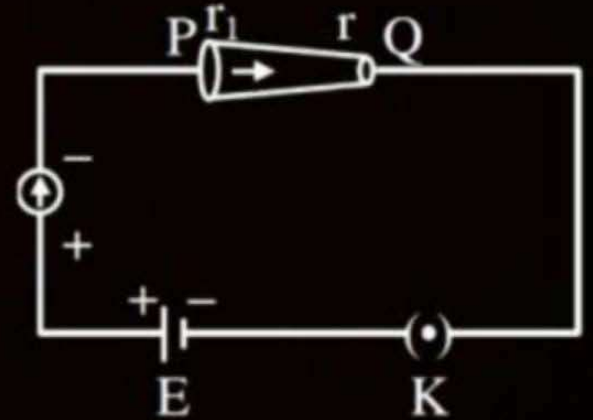
QUESTION

$i = V e n A$ $A\downarrow, v_d \uparrow$

In the given figure, a battery of emf E is connected across a conductor PQ of length 'l' and different area of cross-sections having radii r_1 and r_2 ($r_2 < r_1$). Choose the correct option as one moves from P to Q :

[JEE Main-2021]

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



(1) Drift velocity of electron increases.

$i \longrightarrow$ Same

(2) Electric field ~~decreases~~. $\uparrow$

E

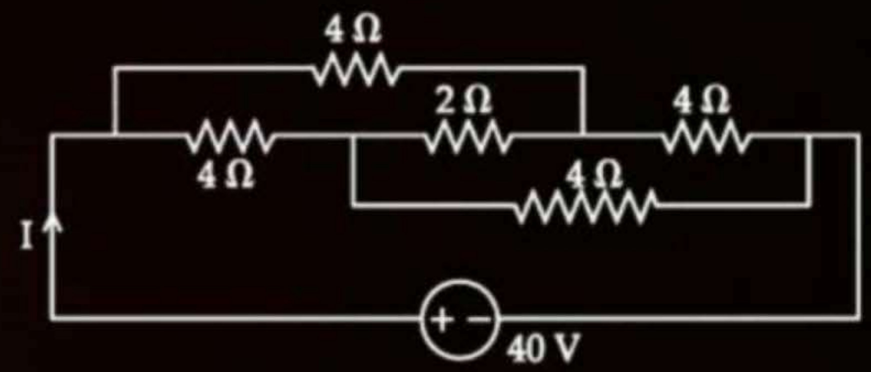
(3) Electron current ~~decreases~~. Same

(4) All of these

Ans : (1)

QUESTION

The current I in the given circuit will be : [JEE Main-2022]



(1) 10 A

(2) 20 A

(3) 4 A

(4) 40 A

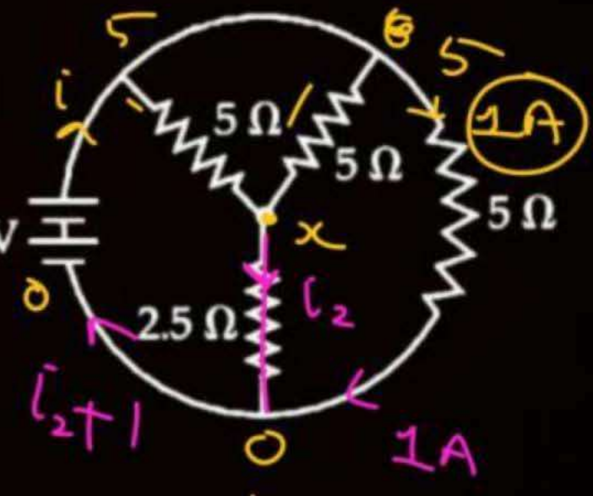
Ans : (1)

QUESTION

The total current supplied to the circuit as shown in figure by the 5V battery is ______ A.

[JEE Main-2022]

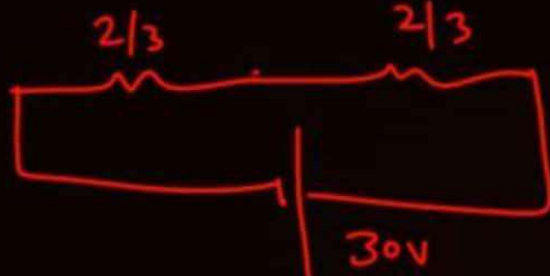
$$\frac{x-5}{5} + \frac{x-5}{5} + \frac{x-0}{2.5} = 0$$

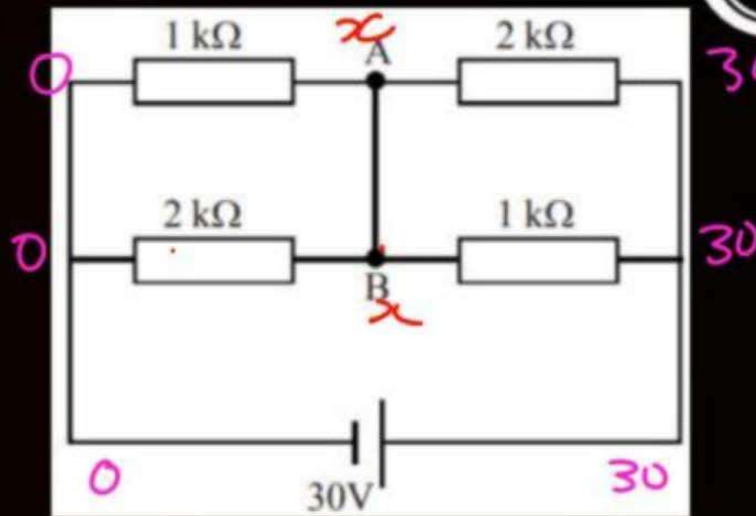


Ans : (2)

QUESTION

Find the current (in mA) in the wire between points A and B.



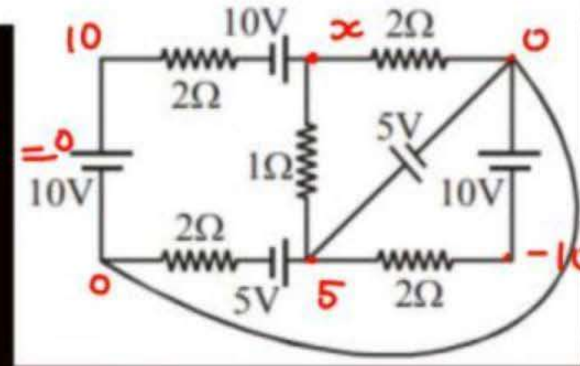


Ans : 7.5 mA

QUESTION

In the given circuit diagram, the current through the 1Ω resistor is given by I amp. Fill 2 I in OMR sheet.

$$\frac{x-10-10}{2}+\frac{x-5}{1}+\frac{x-0}{2}=0$$

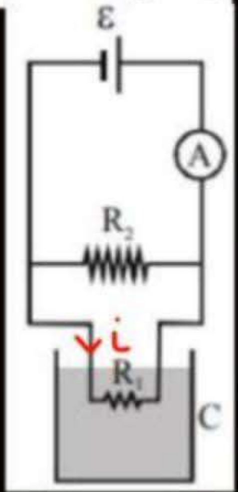


Ans : 5

QUESTION

The coil of a calorimeter C has a resistance of $R_1 = 60\Omega$. The coil R_1 is connected to the circuit as shown in figure. What is the rise in temperature (°C) of 240 grams of water poured into the calorimeter when it is heated for 7 minutes during which a current flows through the coil and the ammeter shows 3A? The resistance $R_2 = 30\Omega$. [Disregard the resistances of the battery and the ammeter, and the heat losses and heat capacity of the calorimeter and the resistor and specific heat of water = 4200 J/kg°C]

$$i^2 R_1 t = m_w s_w \Delta T$$

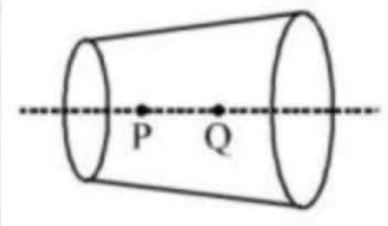


Ans : 25

QUESTION

A wire has a non-uniform cross-section as shown in figure. A steady current flows through it. The drift speed of electrons at points P and Q is v_P and v_Q.

(A) $v_P = v_Q$ (B) $v_P < v_Q$ (C) $v_P > v_Q$ (D) Data insufficient

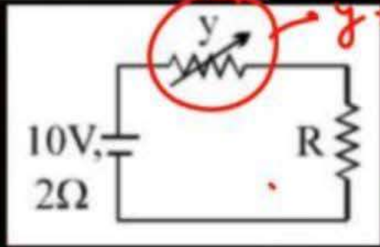


Ans : (C)

QUESTION

In the figure shown the power generated in y is maximum when y = 5Ω. Then R is :-

(A) 2 Ω (B) 6 Ω (C) 5 Ω (D*) 3 Ω



$y = 5$

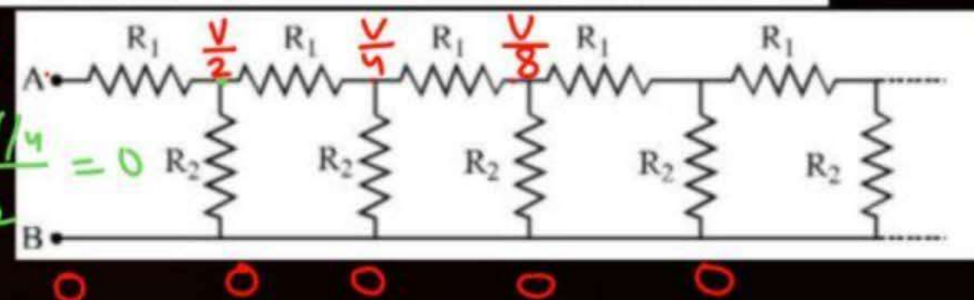
$R + 2 = 5$

Ans : (D)

QUESTION

Consider an infinte ladder network shown in figure. A voltage V is applied between the points A and B. This applied value of voltage is halved after each section.

(A) $R_1/R_2 = 1$ (B*) $R_1/R_2 = 1/2$ (C) $R_1/R_2 = 2$ (D) $R_1/R_2 = 3$



$$\frac{\frac{V}{2}-V}{R_1} + \frac{\frac{V}{2}-0}{R_2} + \frac{\frac{V}{2}-V/4}{R_2} = 0$$

Ans : (B)

QUESTION

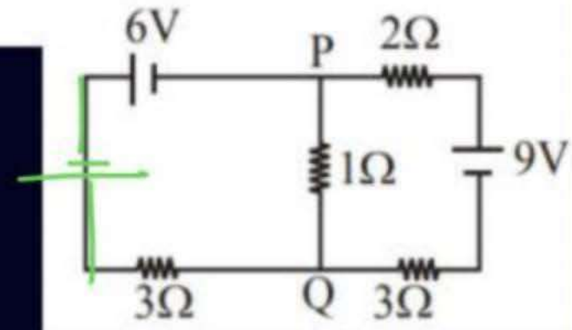
In the circuit shown, the current in the 1Ω resistor is :- **[JEE-Main 2015]**

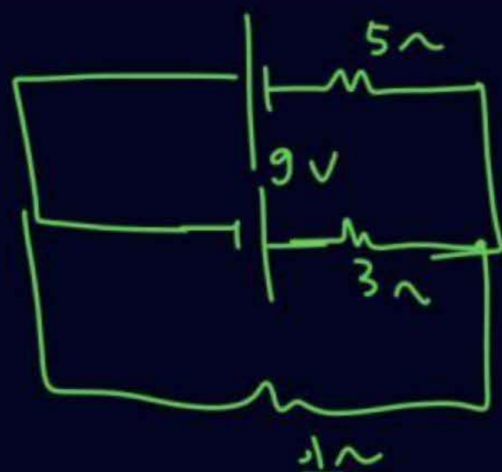
(1) 0.13 A, from Q to P

(2) 0.13 A, from P to Q

(3) 1.3 A, from P to Q

(4) 0A





Ans : (1)

QUESTION

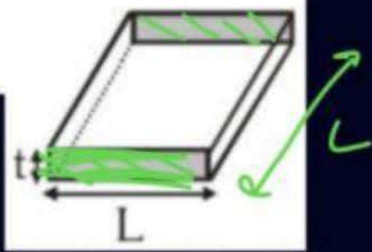
Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is **[IIT-JEE 2010]**

(A) directly proportional to L

(B) directly proportional to t

(C*) independent of L

(D) independent of t



$$R = \rho \frac{l}{A} = \rho \frac{\cancel{L}}{\cancel{L}\, t}$$

$$R = \frac{\rho}{t}$$

Ans : (C)

Cap ≡ 10 min

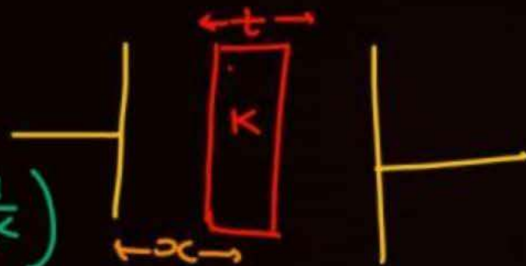
ppt charge

Capacitor

Capacitor

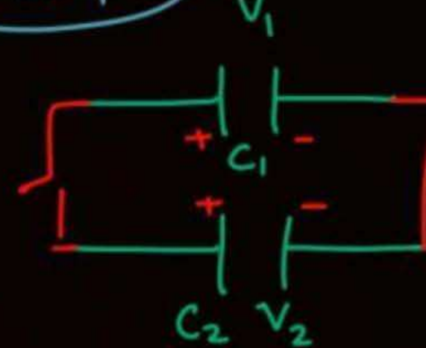
① $C = \frac{A\epsilon_0}{d} \Rightarrow C = \frac{A\epsilon_0 K}{d}$

② $C = \frac{A\epsilon_0}{d - t\left(1 - \frac{1}{K}\right)}$



≡ 10 ques

③ 15-20 ques



$V_{common} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

Energy loss $= \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1 - V_2)^2$

$V_{cm} = \frac{C_1V_1 - C_2V_2}{C_1 + C_2}$

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

4 R-C circuit

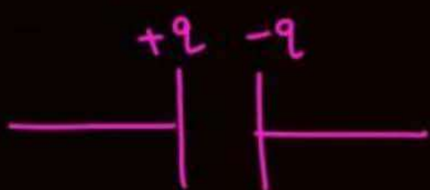
Charging of cap. $q = Q_0(1-e^{-t/\tau})$ $t=0$ cap $\equiv$ wire

$i = \frac{dq}{dt} = i_0 e^{-t/\tau}$ $t=\infty$ cap = $\widehat{\text{tuta}}$ wire

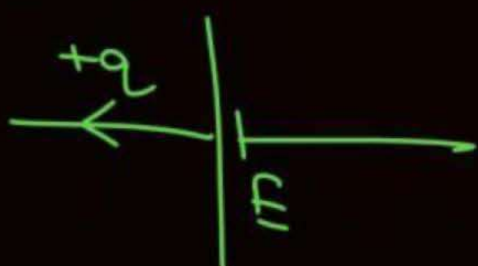
discharge $\Rightarrow$ $q = Q_0 e^{-t/\tau}$

$i = \frac{dq}{dt} \Rightarrow i = i_0 e^{-t/\tau}$

(5) $V=\frac{q}{C}$, $q=CV$



$$U=\frac{1}{2}\frac{q^2}{C}=\frac{1}{2}CV^2$$



$$(WD)_{batt} = +Eq$$

(6) Battery connected

$V \longrightarrow$ same

Battery disconnected

$Q \longrightarrow$ same

$$C=\frac{A\epsilon_0}{d}K$$

QUESTION

A parallel plate capacitor with air between the plate has a capacitance of 15 pF. The separation between the plate becomes twice and the space between them is filled with a medium of dielectric constant 3.5. Then the capacitance becomes $\frac{x}{4}$ pF. The value of x is

[24 January 2023 - Shift 2]

$$C = \frac{A\epsilon_0}{d} =$$

$$C_{\text{नया}} = \frac{A\epsilon_0 K}{2d} = \frac{A\epsilon_0}{d} \times \frac{3.5}{2}$$

$$= 15 \times \frac{3.5}{2} = \frac{x}{4}$$

$$x = 105$$

Ans. (105)

QUESTION 2

A parallel plate capacitor has plate area 40cm^2 and plates separation 2 mm. The space between the plates is filled with a dielectric medium of a thickness 1 mm and dielectric constant 5 . The capacitance of the system is :

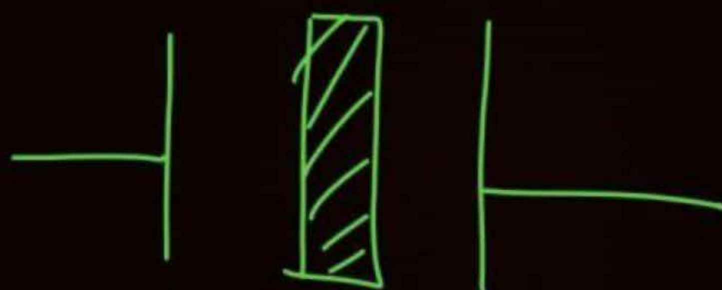
[25 January 2023 - Shift 1]

(1) $24\varepsilon_0$ F

(2) $\frac{3}{10}\varepsilon_0$ F

(3) $\frac{10}{3}\varepsilon_0$ F

(4) $10\varepsilon_0$ F



$$C = \frac{A\epsilon_0}{d - t\left(1 - \frac{1}{K}\right)}$$

$$C = \frac{40 \times 10^{-4} \times \epsilon_0 \times 10^3}{2 - 1\left(1 - \frac{1}{5}\right)}$$

$$= \frac{4\epsilon_0}{2 - \frac{4}{5}} = \frac{20\epsilon_0}{6}$$

Ans. (3)

QUESTION (2)

A capacitor has capacitance 5 μF when it's parallel plates are separated by air medium of thickness d. A slab of material of dielectric constant 1.5 having area equal to that of plates but thickness $\frac{d}{2}$ is inserted between the plates. Capacitance of the capacitor in the presence of slab will be ______ μF. [25 January 2023 - Shift 2]

$C = 5 = \frac{A\epsilon_0}{d}$

$$C = \frac{A\epsilon_0}{d - t\left(1 - \frac{1}{k}\right)} = \frac{A\epsilon_0}{d - \frac{d}{2}\left(1 - \frac{2}{3}\right)}$$

$$= \frac{A\epsilon_0}{d}\left[\frac{1}{1 - \frac{1}{2} \times \frac{1}{3}}\right]$$

$$= \frac{6}{5} \times 5 = 6$$

Ans. (6)

QUESTION

A capacitor of capacitance 900μF is charged by a 100 V battery. The capacitor is disconnected from the battery and connected to another uncharged identical capacitor such that one plate of uncharged capacitor connected to positive plate and another plate of uncharged capacitor connected to negative plate of the charged capacitor. The loss of energy in this process is measured as $x \times 10^{-2}$ J. The value of x is.

[30 January 2023 - Shift 1]

$$\frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1-V_2)^2$$

$V_2=0$

225

$$\frac{1}{2}\times\frac{C}{2}\times(100-0)^2=\frac{1}{2}\times\frac{900\times10^{-6}}{2}\times 10000$$

$$=2.25$$

Ans. (225)

QUESTION 2

A parallel plate capacitor with plate area A and plate separation d is filled with a dielectric material of dielectric constant $K = 4$. The thickness of the dielectric material is x, where $x < d$.

Let C_1 and C_2 be the capacitance of the system for $x = \frac{1}{3}d$ and $x = \frac{2d}{3}$, respectively. If $C_1 = 2\mu F$, the value of C_2 is ______ μF.

[06 April 2023 - Shift 1]

$$C_1 = \frac{A\epsilon_0}{d} = 2 \times \frac{3}{4}$$

$$C_2 = \frac{A\epsilon_0}{d/2} = \frac{2A\epsilon_0}{d}$$

$$= \cancel{2} \times \frac{3}{\cancel{2}} = 3$$

Ans. (3)

QUESTION

As shown in the figure, two parallel plate capacitors having equal plate area of 200 cm^2 are joined in such a way that $a \neq b$. The equivalent capacitance of the combination is $x\varepsilon_0$ F. The value of x is______.

[06 April 2023 - Shift 2]

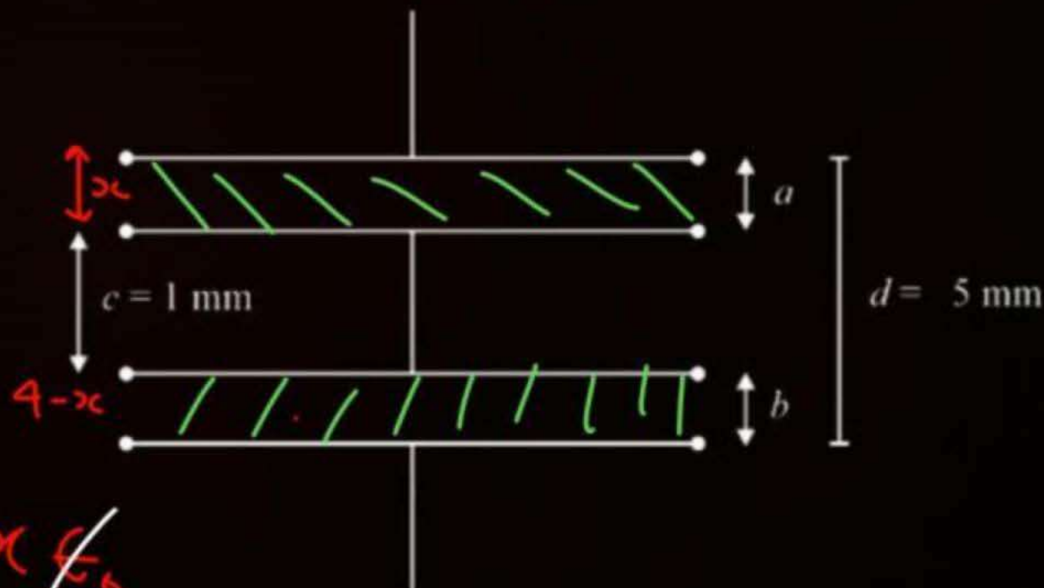
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{eq}} = \frac{x}{A\epsilon_0} + \frac{4-x}{A\epsilon_0}$$

$$\frac{1}{C_{eq}} = \frac{4\times10^{-3}}{A\epsilon_0}$$

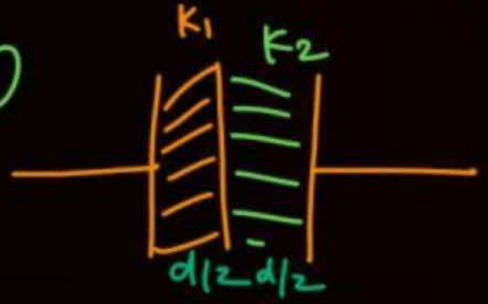
$$C_{eq} = \frac{200\times10^{-4}\,\cancel{\epsilon_0}}{4\times10^{-3}} = x\,\cancel{\epsilon_0}$$

$$= 5$$



Ans : (5)

(1)

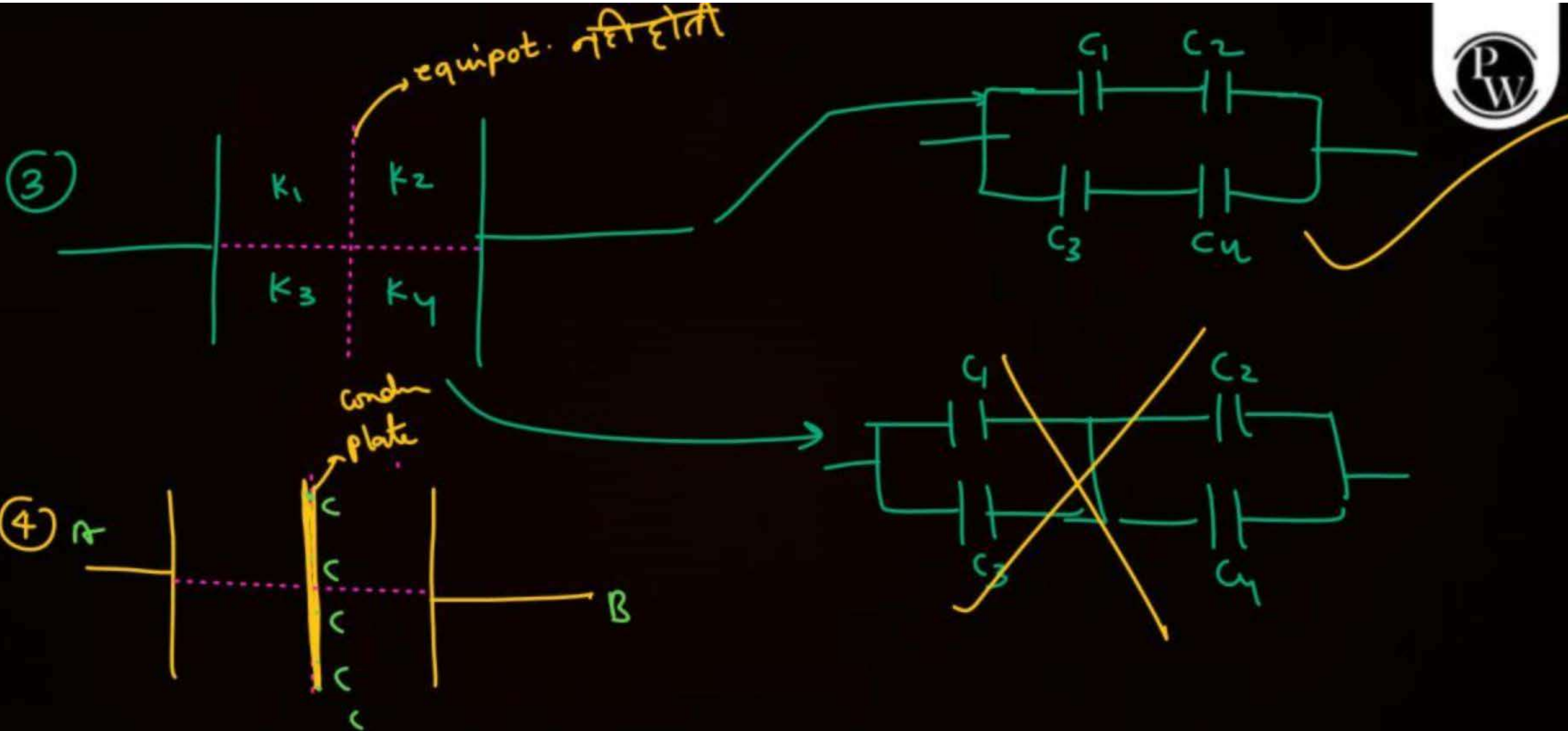


$\equiv$

$$C_1 = \frac{A\,\epsilon_0 K_1}{d/2}$$

(2)

$$C_1 = \frac{A/2\,\epsilon_0 K_1}{d}$$



3
K_1
K_2
K_3
K_4
equipot. नहीं होती
C_1
C_2
C_3
C_4
C_1
C_2
C_3
C_4
condn plate
4
A
B

QUESTION (3)

A 600pF capacitor is charged by 200 V supply. It is then disconnected from the supply and is connected to another uncharged 600pF capacitor. Electrostatic energy lost in the process is ______ μJ.

[08 April 2023 - Shift 2]

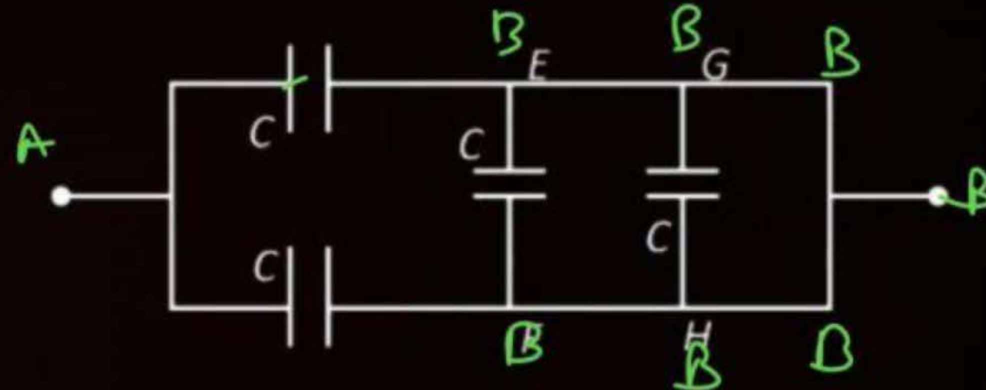
Energy

$$\frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1-V_2)^2$$

Ans. (6)

QUESTION

The equivalent capacitance of the combination shown is [10 April 2023 - Shift 1]



(1) $2C$

(2) $\frac{5}{3}C$

(3) $\frac{C}{2}$

(4) $4C$

Ans. (1)

QUESTION

2

The distance between two plates of a capacitor is d and its capacitance is C_1, when air is the medium between the plates. If a metal sheet of thickness $\frac{2d}{3}$ and of the same area as plate is introduced between the plates, the capacitance of the capacitor becomes C_2. The ratio $\frac{C_2}{C_1}$ is. **[10 April 2023 - Shift 2]**

(1) 3 : 1

(2) 2 : 1

(3) 4 : 1

(4) 1 : 1

Ans. (1)

QUESTION

2 min

PW

A parallel plate capacitor of capacitance 2 F is charged to a potential V. The energy stored in the capacitor is E_1. The capacitor is now connected to another uncharged identical capacitor in parallel combination. The energy stored in the combination is E_2. The ratio $\frac{E_2}{E_1}$ is $\frac{50}{100}$ $E_1 = \frac{1}{2}CV^2 = 100$

[11 April 2023 - Shift 1]

$\text{loss} = \frac{1}{2} \cdot \frac{C}{2} \cdot (V-0)^2 = \frac{CV^2}{4} = 50$

(1) 2 : 1

(2) 2 : 3

(3) 1 : 2

(4) 1 : 4

$$V_{cm} = \frac{CV + 0}{C + C} = \frac{V}{2}$$

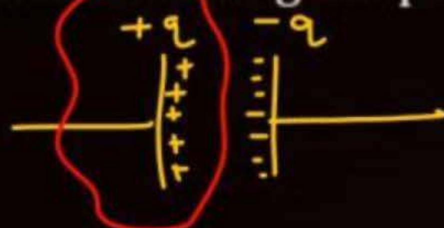
$$U_f = \frac{1}{2}C\left(\frac{V}{2}\right)^2 \times 2 = \frac{CV^2}{4}$$

Ans. (3)

QUESTION

$$\phi = \frac{q_{in}}{\epsilon_0} = \frac{CV}{\epsilon_0}$$

A capacitor of capacitance C is charged to a potential V. The flux of the electric field through a closed surface enclosing the positive plate of the capacitor is:



[11 April 2023 - Shift 2]

$$q = CV$$

(1) $\frac{CV}{\varepsilon_0}$

(2) Zero

(3) $\frac{2CV}{\varepsilon_0}$

(4) $\frac{CV}{2\varepsilon_0}$

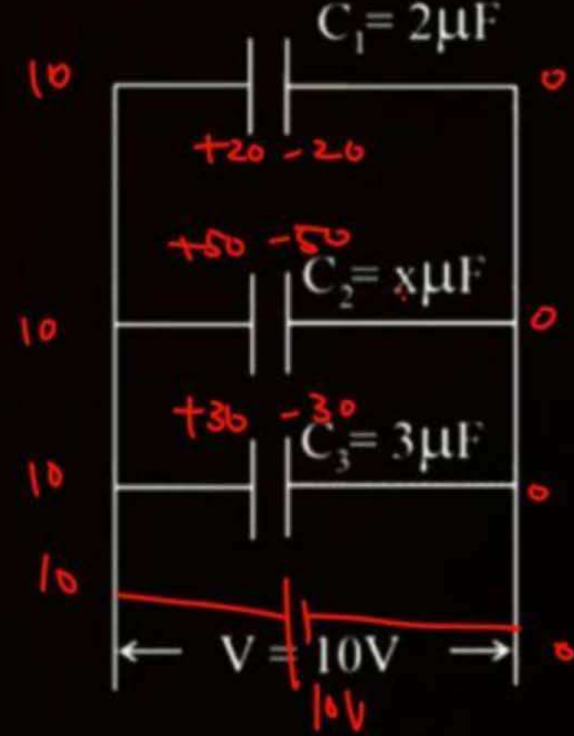
Ans. (1)

QUESTION

In the given figure the total charge stored in the combination of capacitors is $100\mu C$. The value of 'x' is ________.

[15 April 2023 - Shift 1]

$x = 5$



Ans. (5)

QUESTION

A 5 μF capacitor is charged fully by a 220 V supply. It is then disconnected from the supply and is connected in series to another uncharged 2.5 μF capacitor. If the energy change during the charge redistribution is $\frac{X}{100}$ J then value of X to the nearest integer is______.

[JEE Mains-2020]

$\frac{1}{2} \frac{5 \times 2.5}{7.5} \times 10^{-6} \times (220-0)^2$

$x = 4$

$\frac{1}{2} \times \frac{5}{3} 10^{-6} \times 48400$

$= \frac{5 \times \cancel{.048}^{.008}}{\cancel{6}} = .040 = \frac{4}{100}$

Ans. (4)

QUESTION

Repeat

A 10 μF capacitor is fully charged to a potential difference of 50 V. After removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20 V. The capacitance of the second capacitor is:

[JEE Mains-2020]

$$V_c = \frac{C_1 V_1 + C_2 V_2}{C_1 + C_2}$$

(1) 10 μF

(2) 15 μF

(3) 20 μF

(4) 30 μF

$$20 = \frac{10 \times 50 + 0}{10 + C_2}$$

$$200 + 20C_2 = 500$$

$$20C_2 = 300$$

$$C_2 = 15$$

Ans. (2)

QUESTION

A 60pF capacitor is fully charged by a 20 V supply. It is then disconnected from the supply and is connected to another uncharged 60 pF capacitor in parallel. The electrostatic energy that is lost in this process by the time the charge is redistributed between them is (in nJ) _____. [JEE Mains-2020]

$\frac{1}{2} \times \frac{C}{2}(20-0)^2$

Ans. (6)

QUESTION

Effective capacitance of parallel combination of two capacitors C_1 and C_2 is 10 μF. When these capacitors are individually connected to a voltage source of 1V, the energy stored in the capacitor C_2 is 4 times that of C_1. If these capacitors are connected in series, their effective capacitance will be : **[JEE Mains-2020]**

(1) 3.2 μF

(2) 8.4 μF

(3) 1.6 μF

(4) 4.2 μF

$C_1 + C_2 = 10$

$C_1 + 4C_1 = 10$

$C_1 = 2$

$C_2 = 8$

$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{8}$

$C_{eq} = 1.6$

$U_1 = \frac{1}{2} C_1 V^2$

$U_2 = \frac{1}{2} C_2 V^2 = 4U_1$

$C_2 = 4C_1$

Ans. (3)

QUESTION

$R_{eq} = \frac{8}{6} + 2 = \frac{4}{3} + 2 = \frac{10}{3}$

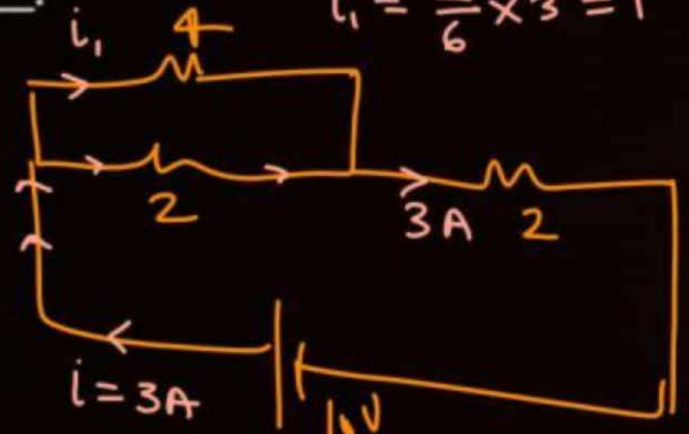
$q = C \times 8$

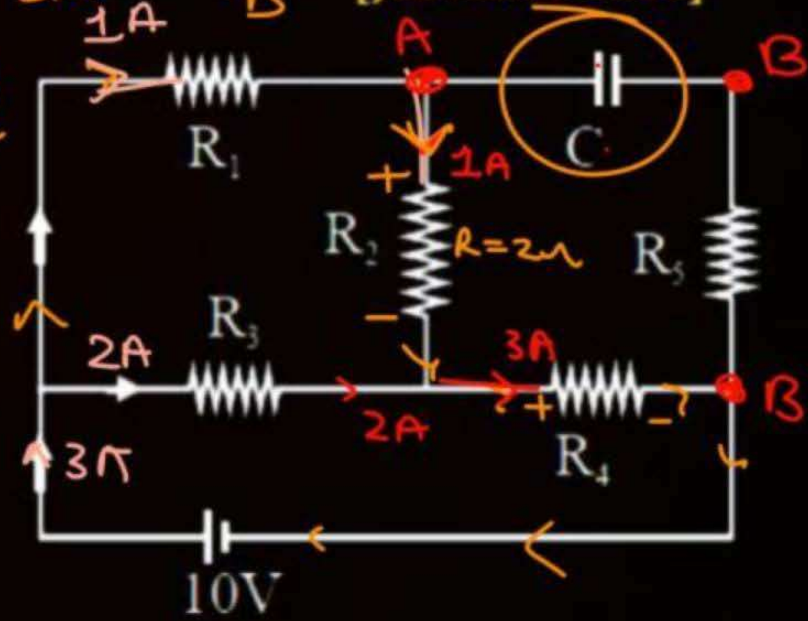
An ideal cell of emf 10 V is connected in circuit shown in figure. Each resistance is 2 Ω. The potential difference (in V) across the capacitor when it is fully charged is ______. [JEE Mains-2020]

$i_1 = \frac{2}{6} \times 3 = 1$

$V_A - 1\times 2 - 3\times 2 = V_B$

$V_A - V_B = 8$





Ans. (8.00)

QUESTION

$q = CV$

In the circuit shown in the figure, the total charge is 750 μC and the voltage across capacitor C_2 is 20 V. Then the charge on capacitor C_2 is: **[JEE Mains-2020]**

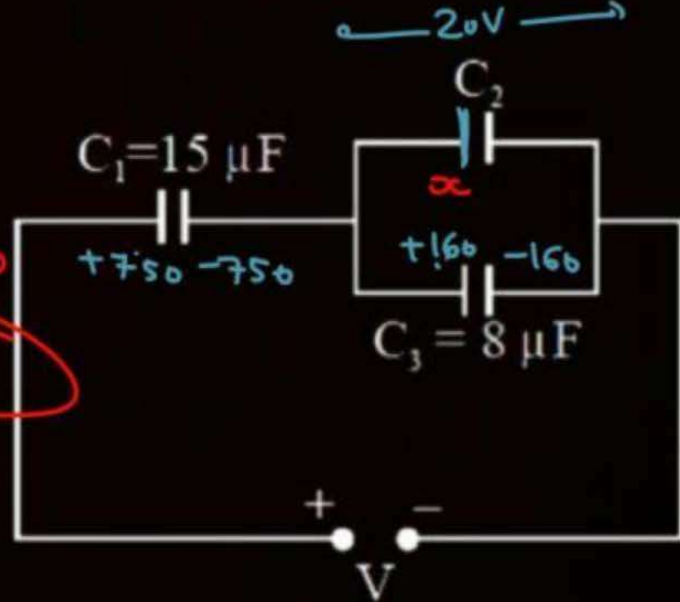
(1) 590 μC

(2) 450 μC

(3) 650 μC

(4) 160 μC

750 −750 +750 −750



$x + 160 = 750$

$x = 590$

Ans. (*)

QUESTION

A capacitor C is fully charged with voltage V_0. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance $\frac{C}{2}$. The energy loss in the process after the charge is distributed between the two capacitors is: [JEE Mains-2020]

$$\frac{1}{2} \times \frac{C \times \frac{C}{2}}{C + \frac{C}{2}} (V - 0)^2$$

(1) $\frac{1}{6}CV_0^2$

(2) $\frac{1}{2}CV_0^2$

(3) $\frac{1}{3}CV_0^2$

(4) $\frac{1}{4}CV_0^2$

Ans. (1)

QUESTION

Two capacitors of capacitances C and 2C are charged to potential differences V and 2V, respectively. These are then connected in parallel in such a manner that the positive terminal of one is connected to the negative terminal of the other. The final energy of this configuration is:

[JEE Mains-2020]

(1) $\frac{9}{2}CV^2$

$$|V_c| = \left|\frac{CV - 2C\,2V}{C+2C}\right| = \left|\frac{3CV}{3C}\right| = V$$

(2) $\frac{25}{6}CV^2$

$$U_f = \frac{1}{2}CV^2 + \frac{1}{2}2CV^2$$
$$= \frac{3}{2}CV^2$$

(3) Zero

(4) $\frac{3}{2}CV^2$

Ans. (4)

QUESTION

In the circuit shown, charge on the 5μF capacitor is: **[JEE Mains-2020]**

(1) $5.45\mu C$

(2) $16.36\mu C$

(3) $10.90\mu C$

(4) $18.00\mu C$

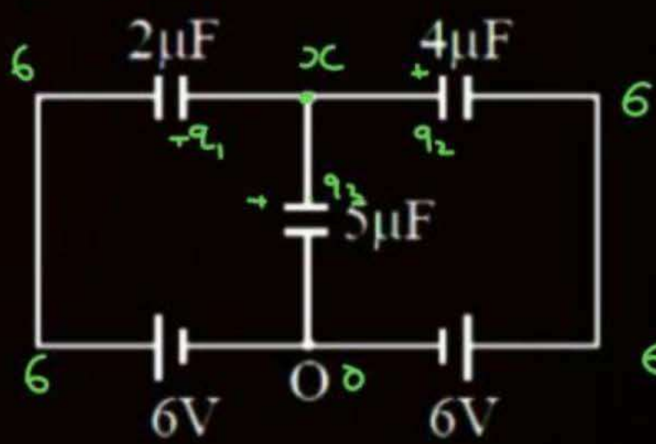
$$q_1 + q_2 + q_3 = 0$$

$$2(x-6) + 4(x-6) + 5(x-0) = 0$$

$$11x - 12 - 24 = 0$$

$$x = \frac{36}{11}$$

$$q_3 = (x-0)\times 5 = 5\times\frac{36}{11} = \frac{180}{11} = 16.36$$



Ans. (2)

QUESTION

$C/2$ $2C$

Two equal capacitors are first connected in series and then in parallel. The ratio of the equivalent capacities in the two cases will be: [JEE Mains-2021]

(1) 4 : 1

(2) 2 : 1

(3) 1 : 4

(4) 1 : 2

Ans. (3)

QUESTION

(*) try it now

An electron with kinetic energy K_1 enters between parallel plates of a capacitor at an angle 'α' with the plates. It leaves the plates at angle 'β' with kinetic energy K_2. Then the ratio of kinetic energies $K_1 : K_2$ will be : **[JEE Mains-2021]**

(1) $\dfrac{\sin^2\beta}{\cos^2\alpha}$

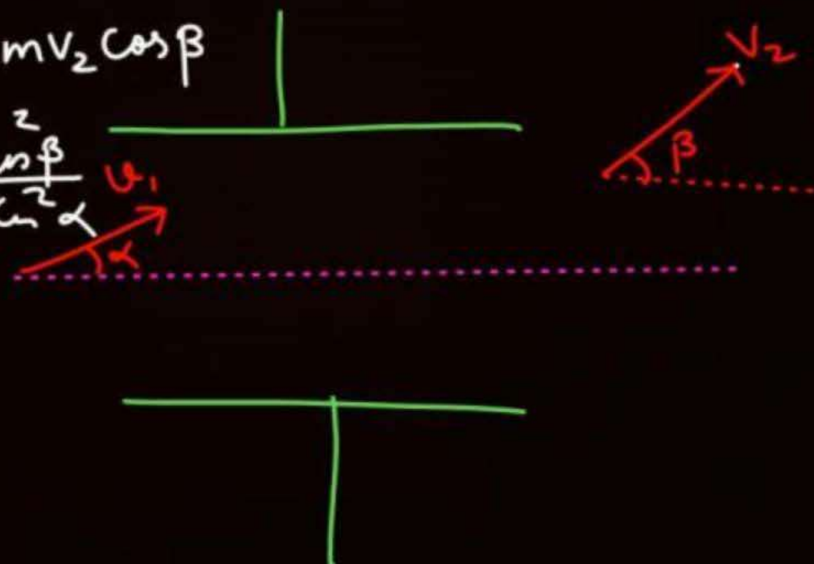
(2) $\dfrac{\cos^2\beta}{\cos^2\alpha}$

(3) $\dfrac{\cos\beta}{\cos\alpha}$

(4) $\dfrac{\cos\beta}{\sin\alpha}$

$$mv_1\cos\alpha = mv_2\cos\beta$$

$$\frac{K_1}{K_2} = \frac{v_1^2}{v_2^2} = \frac{\cos^2\beta}{\cos^2\alpha}$$



Ans. (2)

QUESTION

अच्छा Qun

Consider the combination of 2 capacitors C_1 and C_2, with $C_2 > C_1$, when connected in parallel, the equivalent capacitance is $\frac{15}{4}$ time the equivalent capacitance of the same connected in series. Calculate the ratio of capacitors, $\frac{C_2}{C_1} = x$ [JEE Mains-2021]

(1) $\frac{15}{11}$

(2) $\frac{111}{80}$

(3) $\frac{29}{15}$

(4) $\frac{15}{4}$

$$C_1 + C_2 = \frac{15}{4}\left(\frac{C_1 C_2}{C_1 + C_2}\right)$$

$$4(C_1^2 + C_2^2 + 2C_1C_2) = 15C_1C_2$$

$$4C_1^2 + 4C_2^2 - 7C_1C_2 = 0$$

$$4 + 4\left(\frac{C_2}{C_1}\right)^2 - 7\frac{C_2}{C_1} = 0$$

$$\boxed{4x^2 - 7x + 4 = 0}$$

Ans. (*)

QUESTION

For changing the capacitance of a given parallel plate capacitor, a dielectric material of dielectric constant K is used, which has the same area as the plates of the capacitor. The thickness of the dielectric slab is $\frac{3}{4}$ d, where 'd' is the separation between the plates of parallel plate capacitor. The new capacitance (C') in terms f original capacitance (C_0) is given by the following relation: [JEE Mains-2021]

(1) $C' = \frac{3+K}{4K} C_0$

(2) $C' = \frac{4+K}{3} C_0$

(3) $C' = \frac{4K}{K+3} C_0$

(4) $C' = \frac{4}{3+K} C_0$

$$C = \frac{A\epsilon_0}{d - \frac{3d}{4}\left(1 - \frac{1}{K}\right)} = \frac{A\epsilon_0 4}{d + \frac{3d}{K}}$$

$$= \frac{A\epsilon_0 4K}{d(K+3)}$$

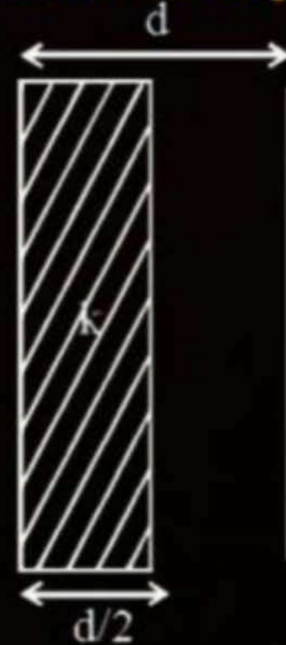
Ans. (3)

QUESTION

(2) Sm

In a parallel plate capacitor set up, the plate area of capacitor is $2\ m^2$ and the plates are separated by 1m. If the space between the plates are filled with a dielectric material of thickness 0.5 m and area $2m^2$ (see fig.) the capacitance of the set-up will be ____ ε_0. (Dielectric constant of the material = 3.2) (Round off to the Nearest Integer)

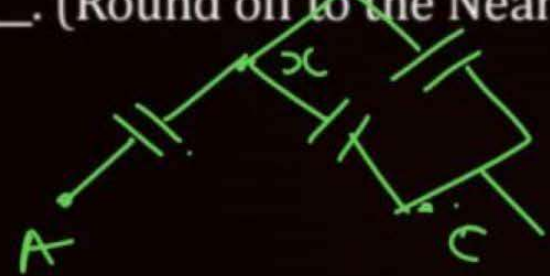
[JEE Mains-2021]

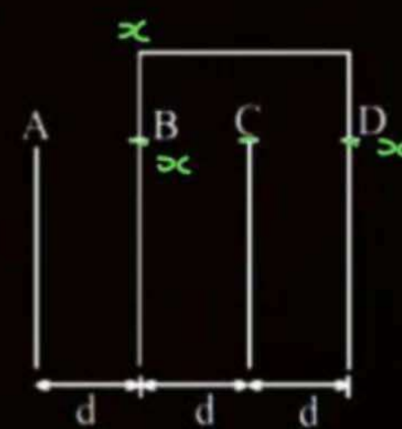


Ans. (3)

QUESTION

Four identical rectangular plates with length, $l = 2$ cm and breadth, $b = \frac{3}{2}$ cm are arranged as shown in figure. The equivalent capacitance between A and C is $\frac{X\varepsilon_0}{d}$. The value of x is ______. (Round off to the Nearest Integer) [JEE Mains-2021]





$$\frac{2C\times C}{2C+C} = \frac{2C}{3} = \frac{2A\epsilon_0}{3\times d}$$

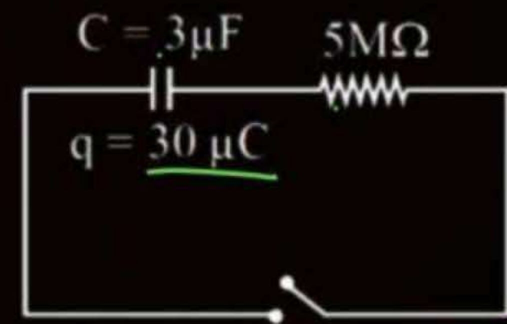
$$= \frac{2}{3}\times\frac{3\times\epsilon_0}{d} = \frac{x\epsilon_0}{d}$$

Ans. (2)

QUESTION

The circuit shown in the figure consists of a charged capacitor of capacity 3 μF and a charge of 30 μC. At time t = 0, when the key is closed, the value of current flowing through the 5 MΩ resistor is 'x' μ-A. The value of 'x to the nearest integer is 2.

[JEE Mains-2021]



$$q = Qe^{-t/\tau}$$

$$i = \frac{dq}{dt} = \frac{Q_0 x}{\tau} e^{-t/\tau}$$

$$i = \frac{Q}{RC} e^{-t/\tau}$$

$t = 0$

$$i_{max} = \frac{Q_0}{RC} = \frac{30 \times \cancel{10^{-6}}}{5 \times 10^{+6} \times 3 \times \cancel{10^{-6}}} = 2 \times 10^{-6}$$

Ans. (2)

QUESTION

$R C \ln 2 = 100\times10^{-6}\times.69 = 69\times10^{-6}$

$= .69\times10^{-4}$

A capacitor of capacitance C = 1 μF is suddenly connected to a battery of 100 volt through a resistance R = 100 Ω. The time taken for the capacitor to be charged to get 50 V is: [Take ln 2 = 0.69]

[JEE Mains-2021]

$q = Q_0(1-e^{-t/\tau})$

$q = EC(1-e^{-t/\tau})$

$50 = 100\times1(1-e^{-t/\tau})$

$\frac{1}{2} = e^{-t/\tau}$

$\cancel{-}\ln 2 = \cancel{-}\frac{t}{\tau}$

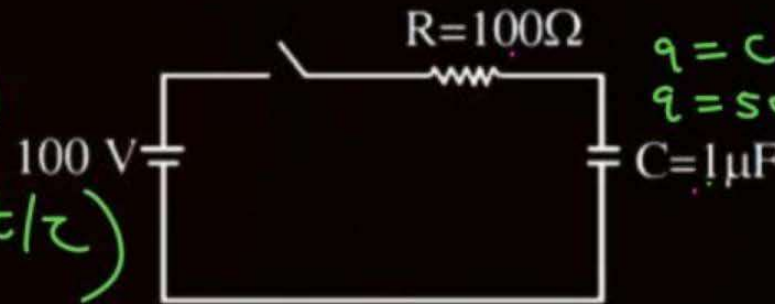
$t = \tau \ln 2$

(1) 1.44×10^{-4} s

(2) 3.33×10^{-4} s

(3) 0.69×10^{-4} s

(4) 0.30×10^{-4} s



$q = CV$

$q = 50\,\mu C$

Ans. (3)

QUESTION

खाली करो।

Two capacitors of capacities 2C and C are joined in parallel and charged up to potential V. The battery is removed and the capacitor of capacity C is filled completely with a medium of dielectric constant K. The potential difference across the capacitors will now be :

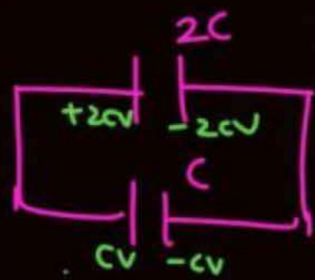
[JEE Mains-2021]

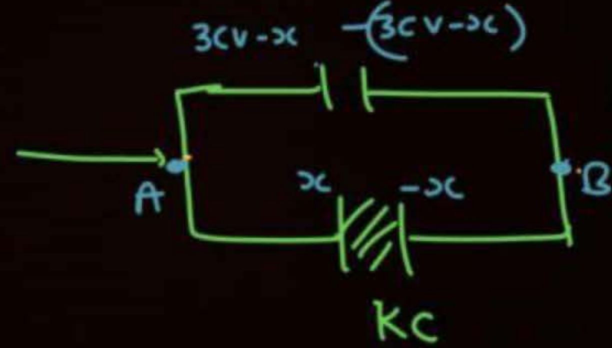
(1) $\frac{V}{K+2}$

(2) $\frac{V}{K}$

(3) $\frac{3V}{K+2}$

(4) $\frac{3V}{K}$





$$V_{AB} = \frac{3CV-x}{2C} = \frac{x}{KC}$$

$$3KCV - Kx = 2x$$

$$3KCV = (2+K)x$$

$$x = \frac{3KCV}{K+2}$$

$$V_{AB} = \frac{x}{KC} = \frac{3KCV}{(K+2)KC} = \frac{3V}{(K+2)}$$

Ans. (3)

QUESTION

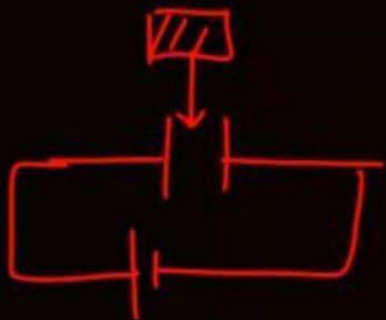
A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20V. If a dielectric material of dielectric constant $K = \frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be :- [JEE-Main-2018]

(1) 0.3 n C (2) 2.4 n C (3) 0.9 n C (4) 1.2 n C

$C \longrightarrow KC = \frac{5}{3} \times 90$

$Q = CV$

Ans : (4)



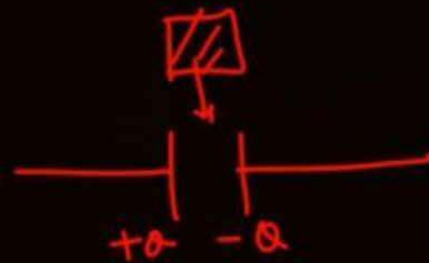
$Q = CV$

$C \longrightarrow KC$

$V \longrightarrow$ Same

$Q \longrightarrow$ K times

$U = \frac{1}{2} CV^2 \longrightarrow KC$



$Q = CV$

$Q \longrightarrow$ Same

$C \longrightarrow KC$

$V \longrightarrow \frac{V}{K}$

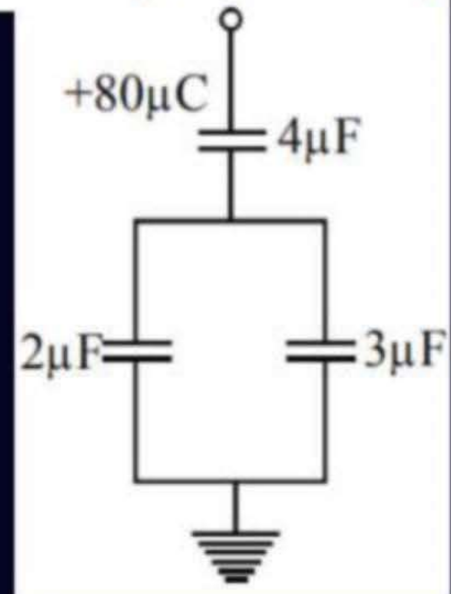
$U = \frac{1}{2}\frac{Q^2}{C} \longrightarrow \frac{U}{K}$

Magnetism

QUESTION

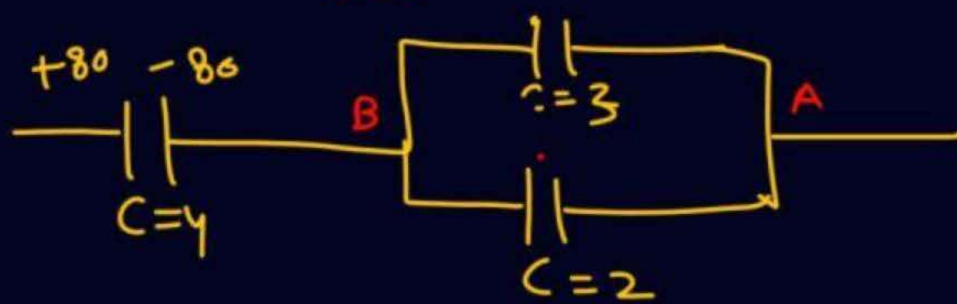
In the given circuit, a charge of +80 μC is given to the upper plate of the 4μF capacitor. Then in the steady state, the charge on the upper plate of the 3μF capacitor is :- [IIT-JEE 2012]

(A) + 32 μC (B) + 40μC (C) + 48μC (D) + 80μC



$q = CV$
↳ Same

$q \propto C$



$80 \rightarrow 3:2$

48, 32

Ans : (C)

magnetism

→ calculation of $B = ?$

→ $q, v, B \equiv \vec{F} = q(\vec{v} \times \vec{B})$

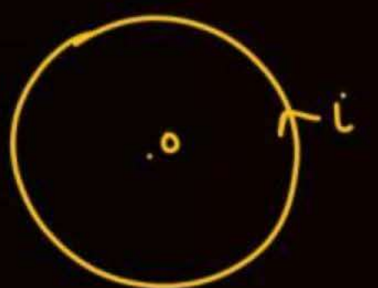
$i, l, B \equiv F = i(\vec{l} \times \vec{B})$

$\vec{\tau} = \vec{m} \times \vec{B}$

Bar magnet . .

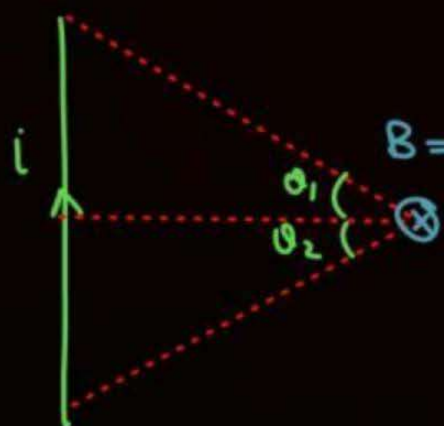
① $d\vec{B} = \dfrac{k\, i\, (d\vec{l} \times \vec{r})}{r^3}$

②



$B_0 = \dfrac{\mu_0 i}{2R}$

③



$B = \dfrac{ki}{r}(\sin\theta_1 + \sin\theta_2)$

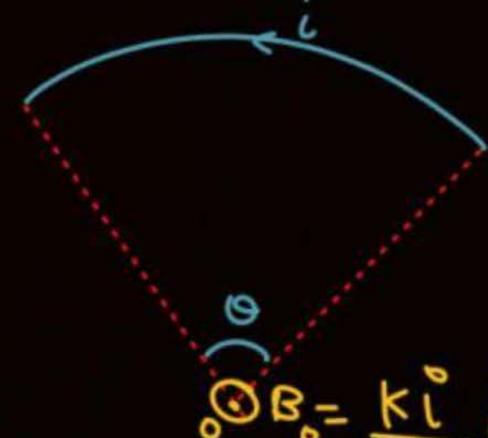
$k = \dfrac{\mu_0}{4\pi}$

④ ∞ wire

$B = \dfrac{2ki}{r} = \dfrac{2\mu_0}{4\pi}\dfrac{i}{r}$

$= \dfrac{\mu_0 i}{2\pi r}$

⑤



o $B_0 = \dfrac{ki}{R}\theta$ (radian)

$\theta = 2\pi$ $B = \dfrac{ki}{R}2\pi = \dfrac{\mu_0 i}{4\pi}\dfrac{2\pi}{R}$

$B = \dfrac{\mu_0 i}{2R}$

* 

$B_{in} = \mu_0 n i$

$n \longrightarrow$ no. of turn per unit length

* Amp Law

$$\oint \vec{B}\, d\vec{l} = \mu_0 i_{enclose}$$

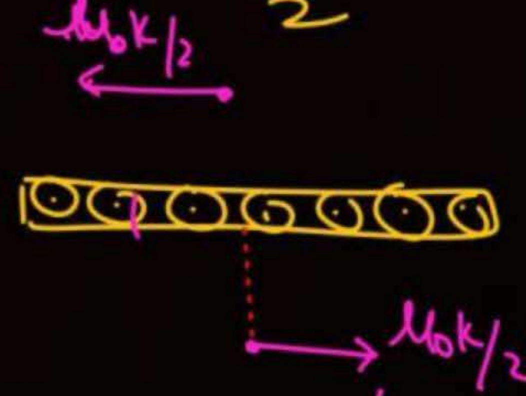
toroid $\equiv$ $B = \mu_0 n i$

$= \mu_0 \frac{N}{2\pi r} i$

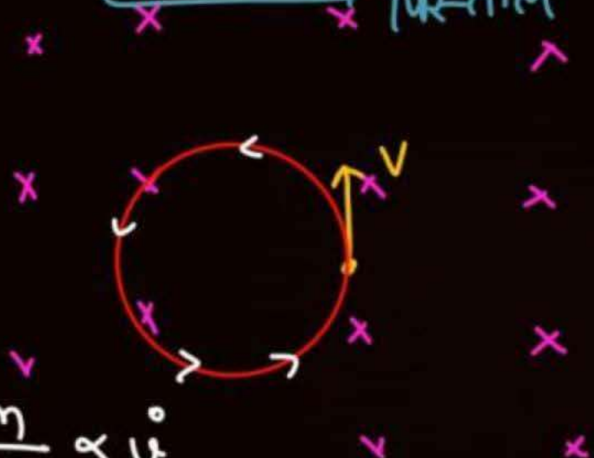
∞ Sheet

$B = \frac{\mu_0 K}{2}$

$K \longrightarrow$ current per unit length



* $\vec{F} = q(\vec{v} \times \vec{B})$ → F.L.H
→ Palm
→ $\hat{i} \times \hat{j} \times \hat{k}$
→ विपरीत

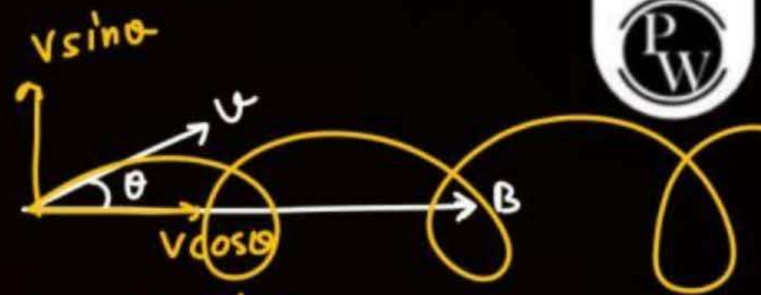


$$qvB = \frac{mv^2}{R}$$

$$R = \frac{mv}{qB} = \frac{P}{qB}$$

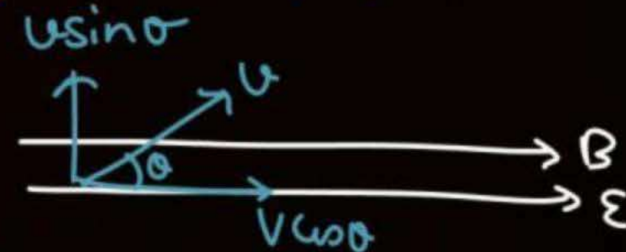
$$T = \frac{2\pi R}{v} = \frac{2\pi m}{qB} \propto v^0$$

* $\omega = \frac{2\pi}{T}$



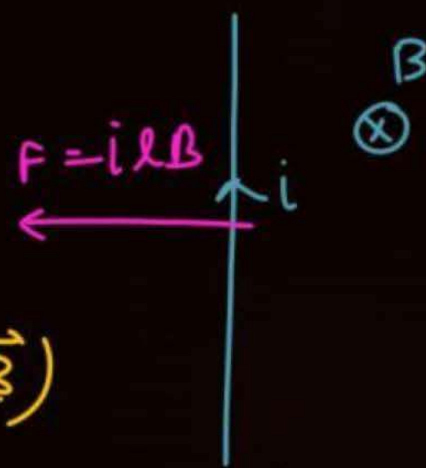
$$r = \frac{mv\sin\theta}{qB}$$

pitch $= T\,v\cos\theta$



* $(WD)_{\text{net by } B} = 0$

* $\underbrace{\vec{F} = i}(\vec{l} \times \vec{B})$



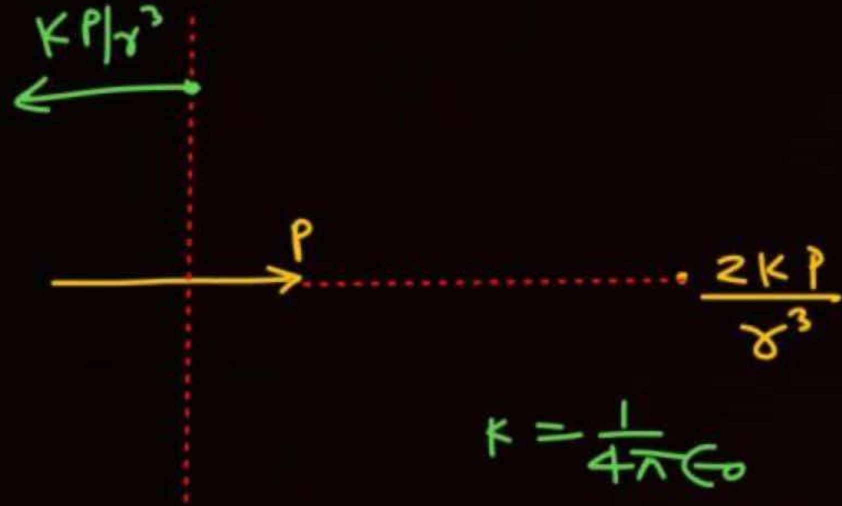
$d\vec{F} = i(d\vec{l} \times \vec{B})$

* magnetic mmt $= i\vec{A} = \vec{m}$

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

$$\left\{\begin{array}{l} \vec{\tau} = \vec{M} \times \vec{B} \\ T = 2\pi\sqrt{\dfrac{I}{mB}} \\ T = 2\pi\sqrt{\dfrac{I}{PE}} \end{array}\right.$$

$\vec{M} = m\vec{l}$



$k = \frac{1}{4\pi\epsilon_0}$

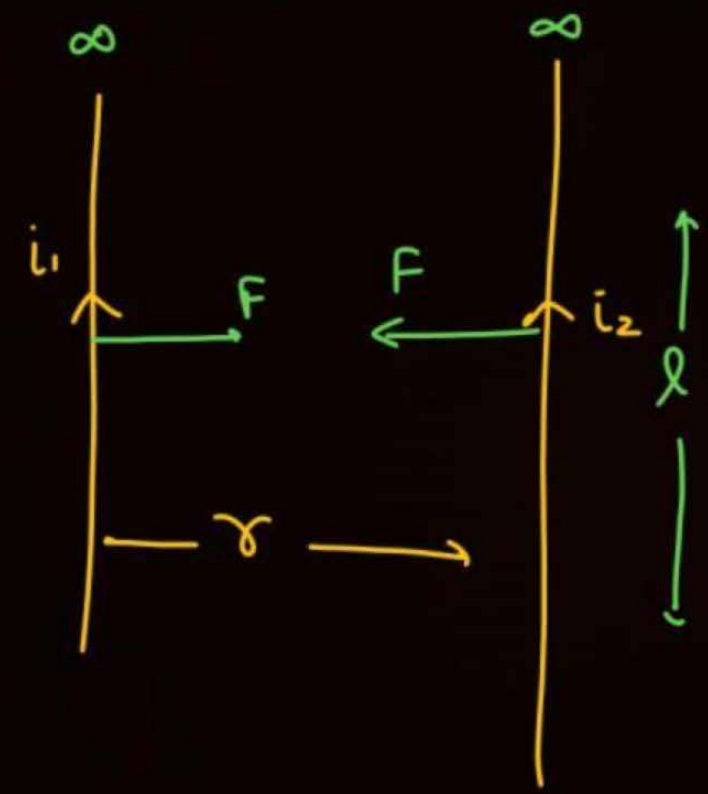
$k = \frac{\mu_0}{4\pi}$

* Moving Coil galvanometer

$\tau = BINA = C\theta$

Current sensitivity $= \frac{\theta}{i} = \frac{BNA}{C}$

Voltage " $= \frac{\theta}{V} = \frac{\theta}{iR} = \frac{BNA}{CR}$



$$F = i_2 l \cdot \frac{2k i_1}{r}$$

Force per unit length $= \dfrac{2k i_1 i_2}{r}$

SALEEM + RAJWANT SIR

$\longrightarrow$ SALAR

Question

A charge Q is moving $\vec{dl}$ distance in the magnetic field $\vec{B}$. Find the value of work done by $\vec{B}$.

(JEE Main-2021)

(A) 1

(B) infinite

(C) zero

(D) –1

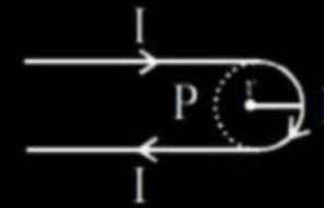
Ans : (C)

Question

A hairpin like shape as shown in figure is made by bending a long current carrying wire. What is the magnitude of a magnetic field at point P which lies on the centre of the semicircle?

(JEE Main-2021)

easy



(A) $\frac{\mu_0 I}{4\pi r}(2-\pi)$

(B) $\frac{\mu_0 I}{4\pi r}(2+\pi)$

(C) $\frac{\mu_0 I}{2\pi r}(2+\pi)$

(D) $\frac{\mu_0 I}{2\pi r}(2-\pi)$

Ans : (B)

Question

$2T \sin d\theta$

A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field. Identify the effect of the field on the wire. (JEE Main 2021)

$T = IRB$

(A) Loop assumes circular shape with its plane normal to the field.

(B) Loop assumes circular shape with its plane parallel to the field.

$F_{net} = 0$

(C) Wire gets stretched to become straight.

(D) Shape of the loop remains unchanged.

Ans : (A)

Question

Earn

Match List I with List II.

	List-I		List-II
(a)	Capacitance, C	(i)	$M^1L^1T^{-3}A^{-1}$
(b)	Permittivity of free space, ε_0	(ii)	$M^{-1}L^{-3}T^4A^2$
(c)	Permeability of free space, μ_0	(iii)	$M^{-1}L^{-2}T^4A^2$
(d)	Electric field, E	(iv)	$M^1L^1T^{-2}A^{-2}$

Choose the correct answer from the options given below (JEE Main-2021)

A. (a) → (iii), (b) → (ii), (c) → (iv), (d) → (i)

B. (a) → (iii), (b) → (iv), (c) → (ii), (d) → (i)

C. (a) → (iv), (b) → (ii), (c) → (iii), (d) → (i)

D. (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)

Ans : (A)

Question

$$\frac{r_1}{r_2} = \sqrt{\frac{m_1}{m_2}} \times \frac{q_2}{q_1} \qquad \frac{6}{5} = \sqrt{\frac{9}{4}} \times \frac{q_2}{q_1}$$

Two charged particles, having same kinetic energy, are allowed to pass through a uniform magnetic field perpendicular to the direction of motion. If the ratio of radii of their circular paths is 6 : 5 and their respective masses ratio is 9 : 4. Then, the ratio of their charges will be: (JEE Main-2022)

$$r = \frac{mv}{qB} = \frac{\sqrt{2m(K.E)}}{qB}$$

same

same

(A) 8 : 5

(B) 5 : 4

(C) 5 : 3

(D) 8 : 7

$$\frac{r_1}{r_2} = \frac{6}{5} \qquad \frac{m_1}{m_2} = \frac{9}{4}$$

$$\frac{q_2}{q_1} = \frac{6}{5} \times \frac{2}{3} = \frac{4}{5}$$

Ans : (B)

Question

A triangular shaped wire carrying 10A current is placed in a uniform magnetic field of 0.5T, as shown in figure. The magnetic force on segment CD is (Given $BC = CD = BD = 5$ cm). **(JEE Main-2022)**

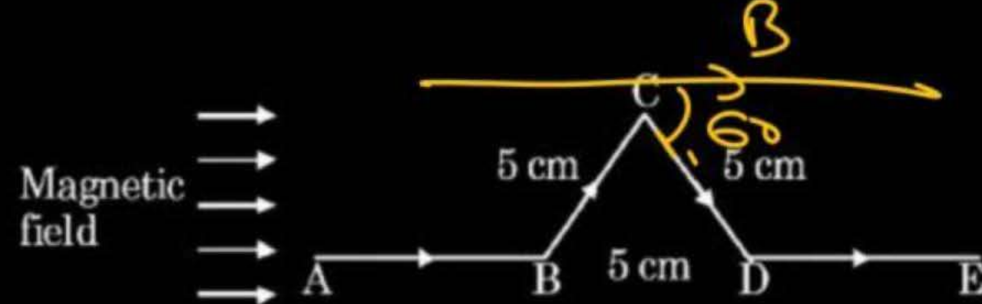
$|i l B \sin 60|$

(A) 0.126 N

(B) 0.312 N

(C) 0.216 N

(D) 0.245 N



Ans : (C)

Question

A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of magnetic field will be equal to

(JEE Main-2022)

$\mu_0 n i$

(A) B

(B) $2B$

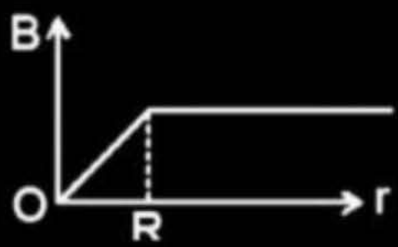
(C) $4B$

(D) $B/2$

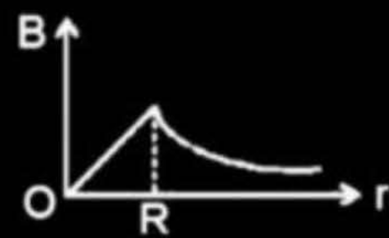
Ans : (A)

An infinitely long hollow conducting cylinder with radius R carries a uniform current along its surface. Choose the correct representation of magnetic field (2) as a function of radial distance (r) from the axis of cylinder. **(JEE Main-2022)**

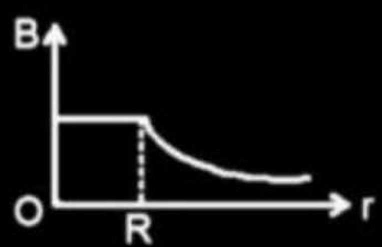
(A)



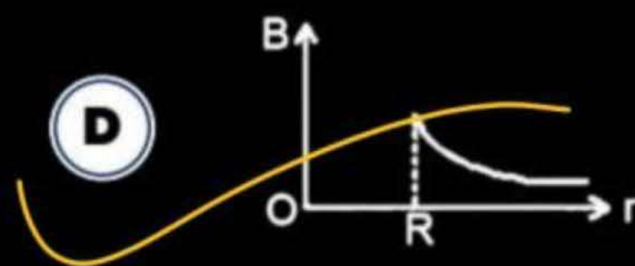
(B)



(C)



(D)



Ans : (D)

Question

A singly ionized magnesium atom $(A = 24)$ ion is accelerated to kinetic energy 5 keV and is projected perpendicularly into a magnetic field B of the magnitude 0.5 T. The radius of path formed will be ______ cm. **(JEE Main-2022)**

$$r = \frac{mv}{qB} = \frac{\sqrt{2m(K.E)}}{qB}$$

Ans : (10)

Question

Two parallel, long wires are kept 0.20 m apart in vacuum, each carrying current of x A in the same direction. If the force of attraction per meter of each wire is 2×10^{-6} N, then the value of x is approximately: **(JEE Main-2022)**

$$\frac{F}{\ell} = \frac{2k\,i_1 i_2}{r} \qquad x = \sqrt{2}$$

(A) 1

(B) 2.4

(C) 1.4

(D) 2

$$2 \times 10^{-6} = \frac{20 \times 10^{-7} \times x^2}{2}$$

Ans : (C)

Question

A charged particle moves along circular path in a uniform magnetic field in a cyclotron. The kinetic energy of the charged particle increases to 4 times of its initial value. What will be the ratio of new radius to the original radius of circular path of the charged particle :

(JEE Main-2022)

$$r = \frac{mv}{qB} = \frac{\sqrt{2m(K.E)}}{qB}$$

(A) 1 : 1

(B) 1 : 2

(C) 2 : 1

(D) 1 : 4

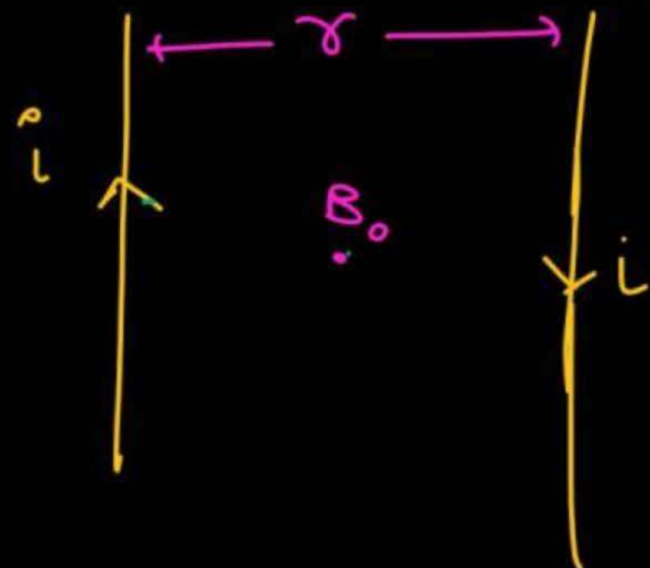
Ans : (C)

Question

$$\frac{\cancel{8}\times 10^{\cancel{-7}}\times i}{\cancel{8}\times 10^{\cancel{-2}}} = \frac{300\times 10^{-6}}{10}\times 10 \qquad \frac{2ki}{r/2}\times 2 = \frac{8ki}{r} = 300\times 10^{-6}$$

Two long current carrying conductors are placed parallel to each other at a distance of 8 cm between them. The magnitude of magnetic field produced at mid-point between the two conductors due to current flowing in them is $300\ \mu T$. The equal current flowing in the two conductors is : **(JEE Main-2022)**

30



A 30A in the ~~same~~ direction

B 30A in the opposite direction

C 60A in the opposite direction.

D 300A in the opposite direction

Ans : (B)

Question

Two long straight wires P and Q carrying equal current 10 A each were kept parallel to each other at 5 cm distance. Magnitude of magnetic force experienced by 10 cm length of wire P is F_1. If distance between wires is halved and currents on them are double, force F_2 on 10 cm length of wire P will be :

(24 January 2023 - Shift 1)

$F/l = \frac{2k i_1 i_2}{r}$

8 times

half

(A) $8 F_1$

(B) $10 F_1$

(C) $F_1/8$

(D) $F_1/10$

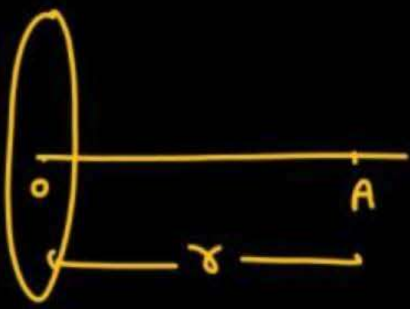
Ans : (A)

Question

$2R^2$

A circular loop of radius r is carrying current I A. The ratio of magnetic field at the centre of circular loop and at a distance r from the center of the loop on its axis is :

(24 January 2023 - Shift 1)



(A) $1 : 3\sqrt{2}$

(B) $3\sqrt{2} : 2$

(C) $2\sqrt{2} : 1$

(D) $1 : \sqrt{2}$

$$B_A = \frac{\mu_0 i R^2}{2(R^2+R^2)^{3/2}}$$

$$B_A = \frac{\mu_0 i \cancel{R^2}}{2\, 2\cancel{R^2} \cdot \sqrt{2}R} = \frac{\mu_0 i}{4\sqrt{2}R}$$

$$\frac{\mu_0 i \; 4\sqrt{2}R}{2R\, \mu_0 i} = 2\sqrt{2}$$

Ans : (C)

Question

A long solenoid is formed by winding 70 turns cm^{-1}. If 2.0 A current flows, then the magnetic field produced inside the solenoid is ______.
($\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$)

(24 January 2023 - Shift 2)

$\mu_0 n i$

(A) 1232×10^{-4} T

(B) 176×10^{-4} T

(C) 352×10^{-4} T

(D) 88×10^{-4} T

$$4\pi \times 10^{-7} \times \frac{70}{10^{-2}} \times 2$$

$$= 56 \times 3.14 \times 10^{-4}$$

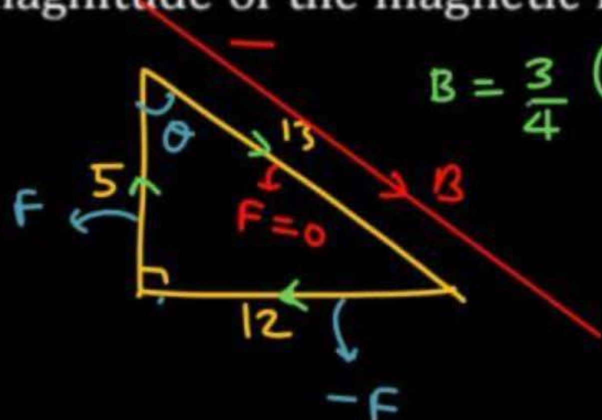
Ans : (B)

Question

$F = ilB\sin\theta \qquad F = i(\vec{l} \times \vec{B})$

A single turn current loop in the shape of a right angle triangle with sides 5 cm, 12 cm, 13 cm is carrying a current of 2A. The loop is in a uniform magnetic field of magnitude 0.75 T whose direction is parallel to the current in the 13 cm side of the loop. The magnitude of the magnetic force on the 5 cm side will be $\frac{x}{130}$ N. The value of x is

$B = \frac{3}{4}$ (Unit fm) **(24 January 2023 - Shift 2)**



$F_{net} = 0$

$x = 9$

$$ilB\sin\theta = \frac{2 \times 5}{100} \times \frac{3}{4} \times \frac{12}{13} = \frac{x}{130}$$

Ans : (9)

Question

Match List I with List II

$\frac{ki}{R}(0+1)\times 2 + \frac{ki}{R}\pi$

(25 January 2023 - Shift 1)

Choose the correct answer from the option given below:

$2\times\frac{\mu_0}{4\pi}\frac{i}{R} - \frac{\mu_0 i}{2R}$

	List – I (Current configuration)		List – II (Magnetic field at point O)
A		I.	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 2]$
B		II.	$B_0 = \frac{\mu_0}{4}\frac{I}{r}$
C		III	$B_0 = \frac{\mu_0 I}{2\pi r}[\pi - 1]$
D		IV	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 1]$

(A) A–III, B–IV, C–I, D–II

(B) A–I, B–III, C–IV, D–II

(C) A–III, B–I, C–IV, D–II

(D) A–II, B–I, C–IV, D–III

Ans : (C)

Question

A solenoid of 1200 turns is wound uniformly in a single layer on a glass tube 2 m long and 0.2 m in diameter. The magnetic intensity at the center of the solenoid when a current of 2 A flows through it is : (25 January 2023 - Shift 1)

(A) $2.4 \times 10^{3}\ \mathrm{A\,m^{-1}}$

(B) $1.2 \times 10^{3}\ \mathrm{A\,m^{-1}}$

(C) $1\ \mathrm{A\,m^{-1}}$

(D) $2.4 \times 10^{-3}\ \mathrm{A\,m^{-1}}$

Ans :

Question

For a moving coil galvanometer, the deflection in the coil is 0.05 rad when a current of 10 mA is passed through it. If the torsional constant of suspension wire is 4.0×10^{-5} Nm rad^{-1}, the magnetic field is 0.01 T and the number of turns in the coil is 200, the area of each turn (in cm^2) is : **(25 January 2023 - Shift 2)**

$$\tau = BINA = C\theta$$

(A) 2.0

(B) 1.0

(C) 1.5

(D) 0.5

$$\frac{1}{100} \times 10 \times 10^{-3} \times 200 \times A = 4 \times 10^{-5} \times \frac{5}{100}$$

$$A = \frac{20 \times 10^{-5}}{100 \times 20 \times 10^{-3}} = 10 \times 10^{-5}$$

$$= 10^{-4}$$

Ans : (B)

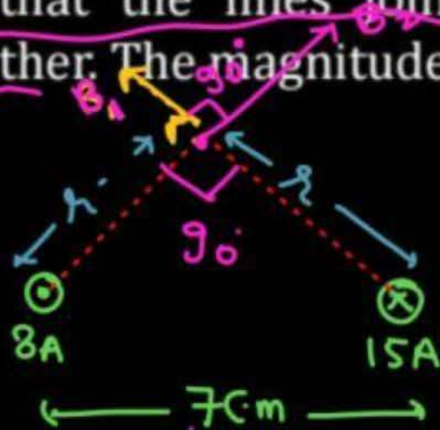
Question

$r\sqrt{2} = 7\,cm$ $\quad r = \frac{7}{\sqrt{2}} \times 10^{-2} = \frac{7}{1.4} \times 10^{-2} = \underline{5 \times 10^{-2}}$

Two long parallel wires carrying currents 8A and 15 A in opposite directions are placed at a distance of 7 cm from each other. A point P is at equidistant from both the wires such that the lines joining the point P to the wires are perpendicular to each other. The magnitude of magnetic field at P is $\times 10^{-6}$ T.

(Given : $\sqrt{2} = 1.4$)

(25 January 2023 - Shift 2)



$B_{net} = \sqrt{B_1^2 + B_2^2}$

$r\sqrt{2} = 7\,cm$

$B_1 = \frac{2ki_1}{r}$

$B_2 = \frac{2ki_2}{r}$

Ans : (68)

Question

The electric current in a circular coil of four turns produces a magnetic induction 32 T at its centre. The coil is unwound and is rewound into a circular coil of single turn, the magnetic induction at the centre of the coil by the same current will be :

(29 January 2023 - Shift 2)

(A) 8 T

(B) 4 T

(C) 2 T

(D) 16 T

4turn

$$B_0 = \frac{\mu_0 i}{2R} \times 4 = 32$$

$$\frac{\mu_0 i}{R} = 16$$

धागा $l = \cancel{2\pi} R \times 4 = \cancel{2\pi} R_{नया}$

$$R_{नया} = 4R$$

$$B_0 = \frac{\mu_0 i}{2R_{नया}} = \frac{\mu_0 i}{2 \times 4R}$$

$$= \frac{\mu_0 i}{8R} = \frac{16}{8} = 2$$

Ans : (C)

Question

$N i A \equiv$

The magnetic moments associated with two closely wound circular coils A and B of radius $r_A = 10$ cm and $r_B = 20$ cm respectively are equal if: (Where N_A, I_A and N_B, I_B are number of turn and current of A and B respectively)

r $2r$

(30 January 2023 - Shift 1)

$$i_1 N_1 \times r_1^2 = N_2 r_2^2 i_2$$

$$i_1 N_1 \cancel{r^2} = N_2 4 \cancel{r^2} i_2$$

(A) $2 N_A I_A = N_B I_B$

(B) $N_A = 2 N_B$

(C) $N_A I_A = 4 N_B I_B$

(D) $4 N_A I_A = N_B I_B$

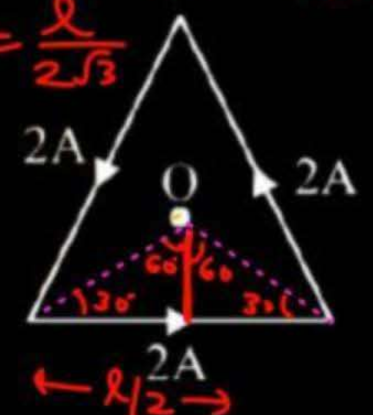
Ans : (C)

Question

As shown in the figure, a current of 2A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid O of the triangle is :
(Neglect the effect of earth's magnetic field.) **(30 January 2023 - Shift 2)**

$\tan 30 = \frac{1}{\sqrt{3}} = \frac{r}{l/2}$

$r = \frac{l}{2\sqrt{3}}$



$\frac{ki}{r}\left(\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right) \times 3$

$\frac{10^{-7} \times \cancel{2} \times \sqrt{3} \times 3 \times \cancel{2}\cancel{\sqrt{3}}}{\cancel{4}\cancel{\sqrt{3}} \times 10^{-2}}$

$3\sqrt{3} \times 10^{-5}$

(A) $4\sqrt{3} \times 10^{-4}$ T

(B) $4\sqrt{3} \times 10^{-5}$ T

(C) $\sqrt{3} \times 10^{-4}$ T

(D) $3\sqrt{3} \times 10^{-5}$ T

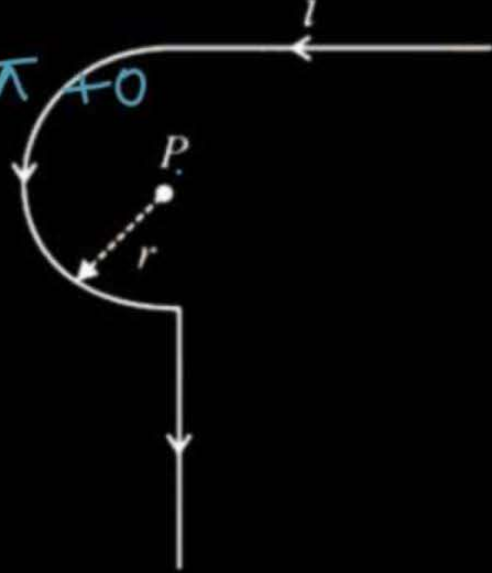
Ans : (D)

Question

Find the magnetic field at the point P in figure. The curved portion is a semicircle connected to two long straight wires.

(01 February 2023 - Shift 1)

$$\frac{Ki}{R}(1+0) + \frac{Ki}{R}\times\pi + 0$$



(A) $\frac{\mu_0 i}{2r}\left(1+\frac{2}{\pi}\right)$

(B) $\frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right)$

(C) $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{2\pi}\right)$

(D) $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{\pi}\right)$

Ans : (C)

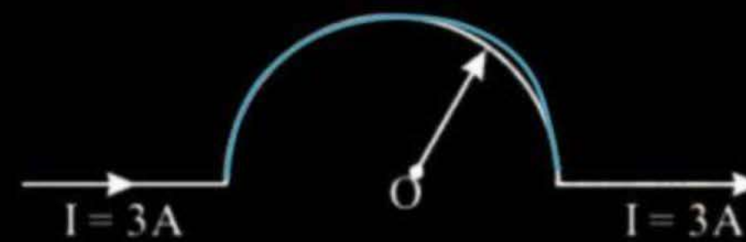
Question

As shown in the figure, a long straight conductor with semicircular arc of radius $\frac{\pi}{10}$ m is carrying current I = 3 A. The magnitude of the magnetic field. at the center O of the arc is: (The permeability of the vacuum = $4\pi \times 10^{-7}$ NA^{-2})

(01 February 2023 - Shift 2)

$\frac{Ki}{R}\pi$

$\frac{10^{-7}\times 3\times \cancel{\pi}\times 10}{\cancel{\pi}}$



(A) $6\ \mu T$

(B) $1\ \mu T$

(C) $4\ \mu T$

(D) $3\ \mu T$

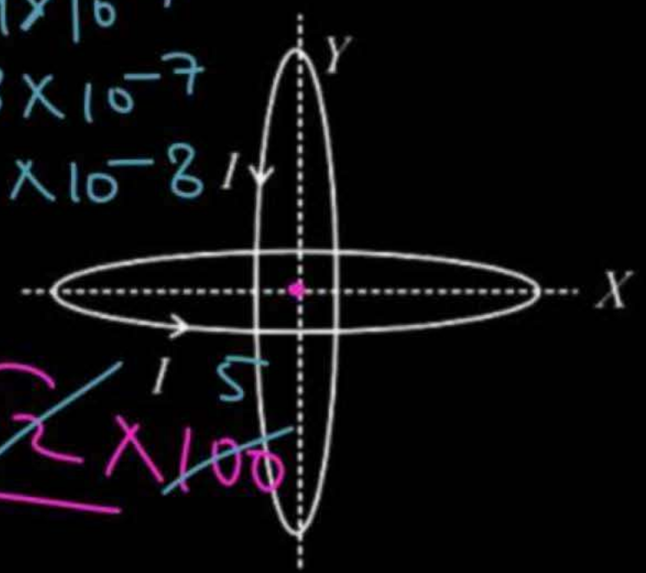
Ans : (D)

Question

Two identical circular wires of radius 20 cm and carrying current $\sqrt{2}$ A are placed in perpendicular planes as shown in figure. The net magnetic field at the centre of the circular wires is <u>628</u> $\times 10^{-8}$ T.

(Take $\pi = 3.14$)

(06 April 2023 - Shift 1)



$$B\sqrt{2}$$

$$= \frac{\mu_0 i}{2R}\sqrt{2}$$

$$= \frac{4\pi \times 10^{-7} \times \cancel{\sqrt{2}} \times \cancel{\sqrt{2}} \times \cancel{100}^{5}}{\cancel{2} \times \cancel{20}}$$

$20\pi \times 10^{-7}$

$20 \times 3.14 \times 10^{-7}$

$= 62.8 \times 10^{-7}$

$= 628 \times 10^{-8}$

Ans : (628)

Question H/W

A proton with a kinetic energy of 2.0eV moves into a region of uniform magnetic field of magnitude $\frac{\pi}{2}\times10^{-3}$ T. The angle between the direction of magnetic field and velocity of proton is 60°. The pitch of the helical path taken by the proton is ______ cm. (Take, mass of proton = 1.6×10^{-27} kg and charge on proton = 1.6×10^{-19} C).

(06 April 2023 - Shift 2)

Pitch $= T \times v\cos 60^\circ$

Calculate

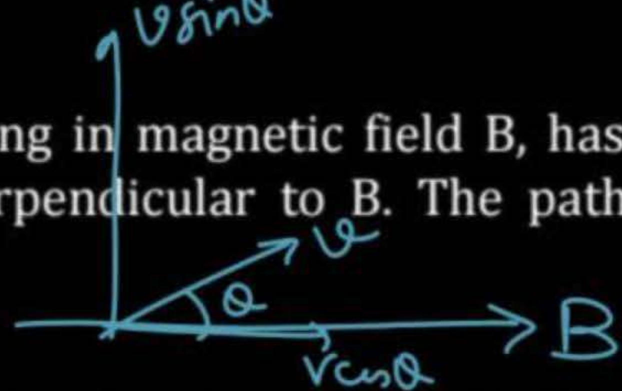
$$= \frac{2\pi m}{qB} \times v \times \frac{1}{2}$$

Ans : (40)

Question

A charge particle moving in magnetic field B, has the components of velocity along B as well as perpendicular to B. The path of the charge particle will be

(08 April 2023 - Shift 1)



(A) helical path with the axis perpendicular to the direction of magnetic field B

(B) helical path with the axis along magnetic field B

(C) circular path

(D) straight along the direction of magnetic field B

Ans : (B)

Question

रटा है तुम्हें

The ratio of magnetic field at the centre of a current carrying coil of radius r to the magnetic field at distance r from the centre of coil on its axis is $\sqrt{x} : 1$. The value of x is ________.

(08 April 2023 - Shift 2)

$2\sqrt{2} = \sqrt{x}$

$x = 8$

Ans : (8)

Question

$\tau = BINA = C\theta$

$\frac{\theta}{i} = \frac{BNA}{C}$

N बढ़ाए ⇒ Length बढ़ जाएगी ⇒ R बढ़ेगा

Given below are two statements:

Statement I: If the number of turns in the coil of a moving coil galvanometer is doubled then the current sensitivity becomes double.

Statement II: Increasing current sensitivity of a moving coil galvanometer by only increasing the number of turns (2 double) in the coil will also increase its voltage sensitivity in the same ratio $= \frac{BNA}{CR} \equiv$ indep.

In the light of the above statements, choose the correct answer from the options given below:

(10 April 2023 - Shift 1)

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

(B) Statement I is false but Statement II is true

(C) Both Statement I and Statement II are false

(D) Both Statement I and Statement II are true

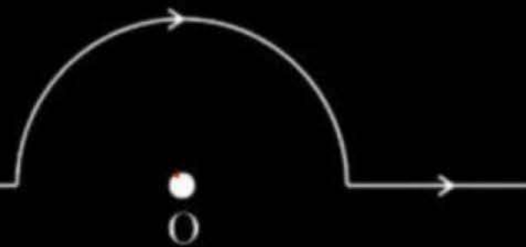
Ans : (A)

Question

A straight wire carrying a current of 14 A is bent into a semicircular arc of radius 2.2 cm as shown in the figure. The magnetic field produced by the current at the centre O of the arc is ___2___ $\times 10^{-4}$ T. **(10 April 2023 - Shift 2)**

$$0 + \frac{K i}{R}\theta + 0$$

$$\frac{10^{-7} \times \cancel{14}^{2} \times \cancel{22} \times 10}{\cancel{2.2} \times 10^{-2} \times \cancel{7}}$$



Ans : (2)

Question

An electron is allowed to move with constant velocity along the axis of current carrying straight solenoid.

(A) The electron will experience magnetic force along the axis of the solenoid.
(B) The electron will not experience magnetic force.
(C) The electron will continue to move along the axis of the solenoid.
(D) The electron will be accelerated along the axis of the solenoid.
(E) The electron will follow parabolic path-inside the solenoid.

Choose the correct answer from the option given below: **(11 April 2023 - Shift 2)**

(A) B, C and D only

(B) A and D only

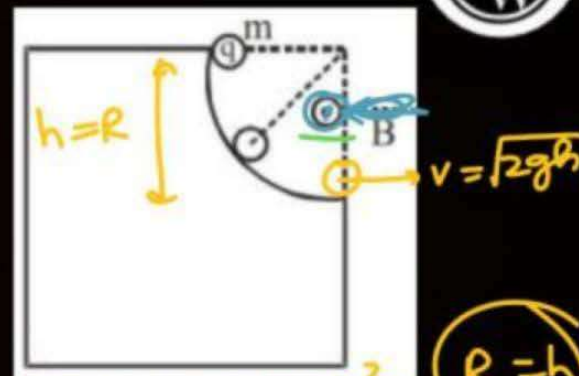
(C) B and C only

(D) B and E only

Ans : (C)

QUESTION

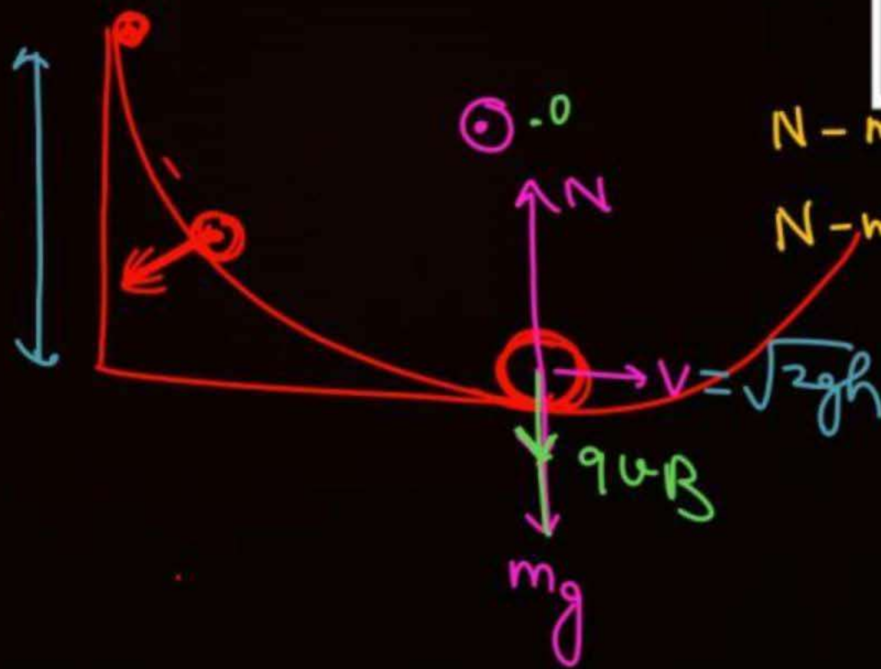
A charged sphere of mass m and charge q starts sliding from rest on a vertical fixed circular track of radius R from the position as shown in figure. There exists a uniform and constant horizontal magnetic field of induction B. Find the maximum force exerted by the track on the sphere.



$\sqrt{2gh}$

$mgh + 0 + 0 = \frac{1}{2}mv^2 - 0$

$v = \sqrt{2gh}$



$R = h$

$N - mg - qvB = \frac{mv^2}{R}$

$N - mg - qvB = \frac{m\,2gh}{R}$

$N - mg - qvB = 2mg$

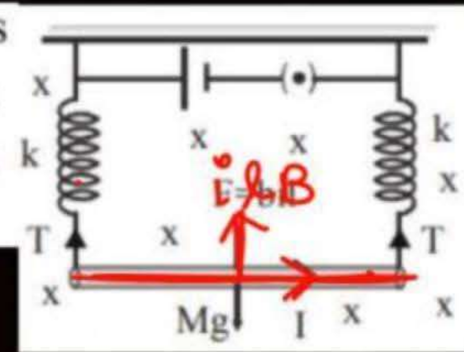
$N = 3mg + q\sqrt{2gh}\,B$

Ans : $= 3mg + qB\sqrt{2gR}$

QUESTION

$\rightarrow x_2 = 3\ cm$

A metal rod of mass 10 gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. Determine the magnetic field assuming acceleration due to gravity to be 10 m/s². $x_1 = 4\ cm$



$$2kx_1 = mg \quad \text{— (1)}$$

$$kx_2 + i\ell B + kx_2 = mg \qquad x_2 = 3\ cm$$

$$\text{— (2)}$$

$$\cancel{i\ell B = mg}$$

Ans : = 1.5×10^{-2} T

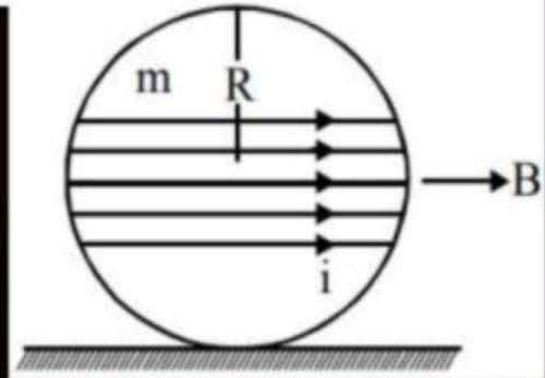
QUESTION

$m \equiv \hat{j} \quad B \rightarrow \hat{i} \equiv -\hat{k}$

A wire is wrapped $N = 10$ times over a solid sphere of mass $m = 5\text{kg}$, current $I = 2\text{A}$, which is placed on a smooth horizontal surface. A horizontal magnetic field of induction $|\vec{B}| = 10\text{T}$ is present. Find the angular acceleration experienced by the sphere. Assume that the mass of the wire is negligible compared to the mass of the sphere. If answer is $20n\pi$. Write value of n.

$$\vec{\tau} = \vec{m} \times \vec{B}$$

$$\tau = i\pi R^2 B \times N = I\alpha$$



Ans : 5

QUESTION

A circular coil of 20 turns and radius 10 cm is placed in a uniform magnetic field of 0.10 T normal to the plane of the coil. If the current in the coil is 5.0 A, what is the *(NCERT)*

(a) total, torque on the coil, $(\vec{m} \times \vec{B})$ N

(b) total force on the coil, $= 0$

(The coil is made of copper wire of cross-sectional area 10^{-5} m^2, and the free electron density in copper is given to be about 10^{29} m^{-3}.)

Ans : (a) Zero, (b) zero

QUESTION

3 mint

$\Delta Q = \int i\,dt = \frac{mv}{\ell B} = \frac{m\sqrt{2gh}}{\ell B}$

A U-shaped wire of mass m and length l is immersed with its two ends in mercury (see figure). The wire is in a homogeneous field of magnetic induction **B**. If a charge, that is, a current pulse $q = \int i\,dt$, is sent through the wire, the wire will jump up.

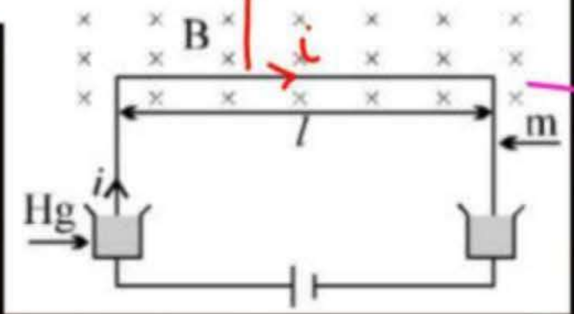
$J = \int i\ell B\,dt = mv - 0$

$\ell B \int i\,dt = mv$

$\ell B q = mv$

Calculate, the height h that the wire reaches, the size of the charge or current pulse, assuming that the time of the current pulse is very small in comparision with the time of flight. Make use of the fact that impulse of force equals $\int F\,dt$, which equals mv. Evaluate q for $B = 0.1$ Wb/m^2, $m = 10$gm, $\ell = 20$cm & $h = 3$ meters. [$g = 10$ m/s^2]

$\Delta Q = \frac{m\sqrt{2gh}}{\ell B}$



Ans : $\sqrt{15}$ C

$$\Delta q = \int i\,dt \qquad = \frac{m\sqrt{2gh} - 0}{lB}$$

QUESTION

Two identical long conducting wires AOB and COD are placed at right angles to each other. The wire AOB carries an electric current I_1 and COD carries a current I_2. The magnetic field on a point lying at a distance d from O, in a direction perpendicular to the plane of the wires AOB and COD, will be given by-

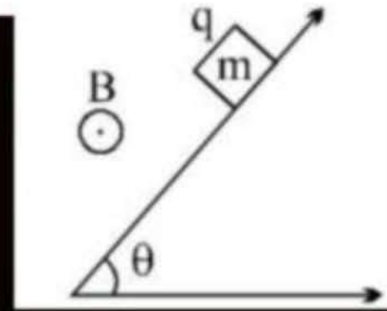
(A) $\frac{\mu_0}{2\pi}\left(\frac{I_1 + I_2}{d}\right)^{1/2}$ (B*) $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)^{1/2}$ (C) $\frac{\mu_0}{2\pi d}(I_1 + I_2)$ (D) $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)$

Ans : (B)

QUESTION

A block of mass m & charge q is released on a long smooth inclined plane magnetic field B is constant, uniform, horizontal and parallel to surface as shown. Find the time from start when block loses contact with the surface.

(A) $\frac{m\cos\theta}{qB}$ (B) $\frac{m\operatorname{cosec}\theta}{qB}$ (C*) $\frac{m\cot\theta}{qB}$ (D) none



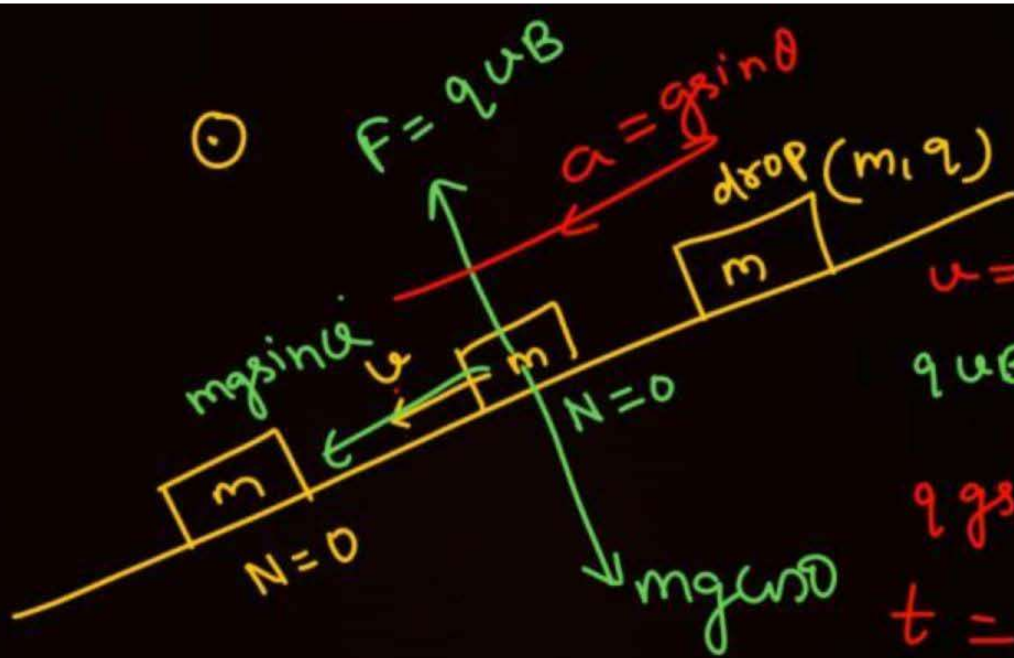
$v = g\sin\theta\, t$

$qvB = mg\cos\theta$

$q \cdot g\sin\theta \cdot t \cdot B = \cancel{m}g\cos\theta$

$t = \frac{m\cos\theta}{Bq\sin\theta} = \frac{m\cot\theta}{qB}$

Ans : (C)



$$v = 0 + g\sin\theta\, t$$

$$quB = mg\cos\theta$$

$$q\, g\sin\theta\, t\, B = mg\cos\theta$$

$$t =$$

QUESTION

$\vec{M} = \frac{q}{2m} \times \vec{L} = \frac{q}{2m}(mR^2\omega)$

Column-I (Magnetic moment of)		Column-II
(A) a uniformly charged ring rotating uniformly about its axis	(p)	$\frac{q\omega r^2}{5}$
(B) a charged particle rotating uniformly about a point $\frac{q}{2m} \times mR^2\omega$	(q)	$\frac{q\omega r^2}{4}$
(C) a uniformly charged disk rotating uniformly about its axis $\frac{q}{2m} \times \frac{mR^2}{2}\omega$	(r)	$\frac{q\omega r^2}{3}$
(D) a uniformly charged spherical shell rotating uniformly about one of its diameter	(s)	$\frac{q\omega r^2}{2}$
(E) a uniformly charged sphere rotating	(t)	$q\omega r^2$

Ans. (A)-s; (B)-s; (C)-q; (D)-r; (E)-p

$$\vec{m} = \vec{L}\,\frac{q}{2m}$$

QUESTION

$F = q(v \times B)$

$-\hat{j} = q(\hat{i} \times \hat{k})$ $\quad F \equiv -\hat{j} \quad B \equiv \hat{k} \quad v \equiv \hat{i}$

At t = 0 a charge q is at the origin and moving in the y-direction with velocity $\vec{v} = v\,\hat{j}$. The charge moves in a magnetic field that is for y > 0 out of page and given by $B_1\,\hat{z}$ and for y < 0 into the page and given $-B_2\,\hat{z}$. The charge's subsequent trajectory is shown in the sketch. From this information, we can deduce that

$R_1 > R_2$

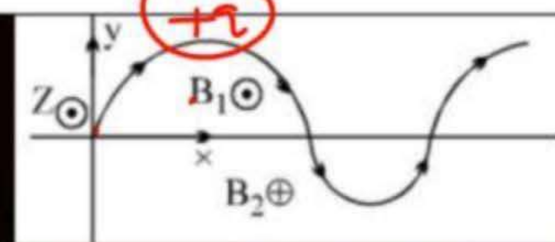
$\frac{mv}{qB_1} > \frac{mv}{qB_2}$

(A) q > 0 and $|B_1| < |B_2|$

(B) q < 0 and $|B_1| < |B_2|$

(C) q > 0 and $|B_1| > |B_2|$

(D) q < 0 and $|B_1| > |B_2|$



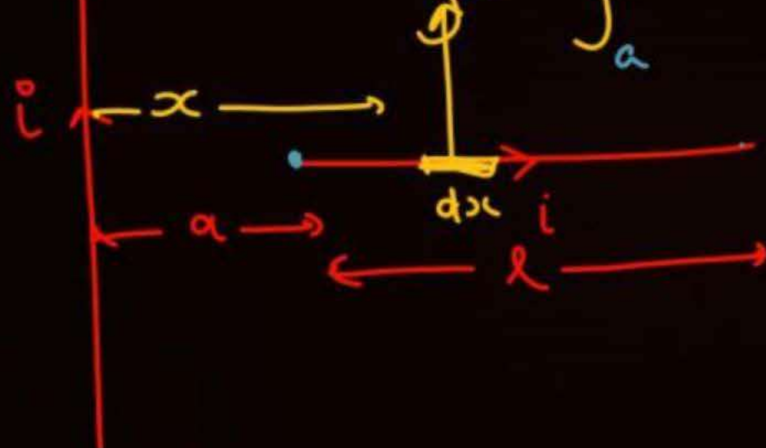
$r = \frac{mv}{qB}$

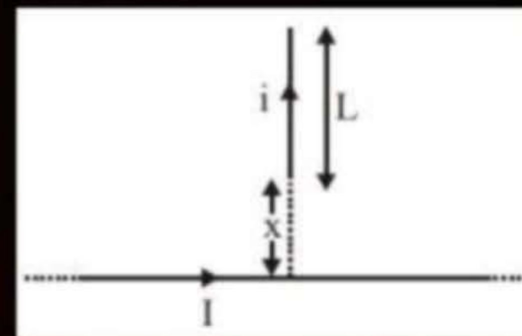
Ans : (A)

QUESTION

The magnetic force between wires as shown in figure is :-

$$\int dF = \int_{a}^{a+l} i \cdot dx \cdot \frac{2k\, i}{x}$$





Ans : (*)

QUESTION

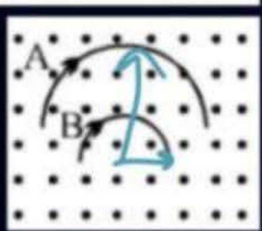
Two particles A and B of masses m_A and m_B respectively and having the same charge are moving in a plane. A uniform magnetic field exists perpendicular to this plane. The speeds of the particles are v_A and v_B respectively and the trajectories are as shown in the figure. Then **[JEE, 2001 (Scr)]**

(A) $m_A v_A < m_B v_B$

(B*) $m_A v_A > m_B v_B$

(C) $m_A < m_B$ and $v_A < v_B$

(D) $m_A = m_B$ and $v_A = v_B$



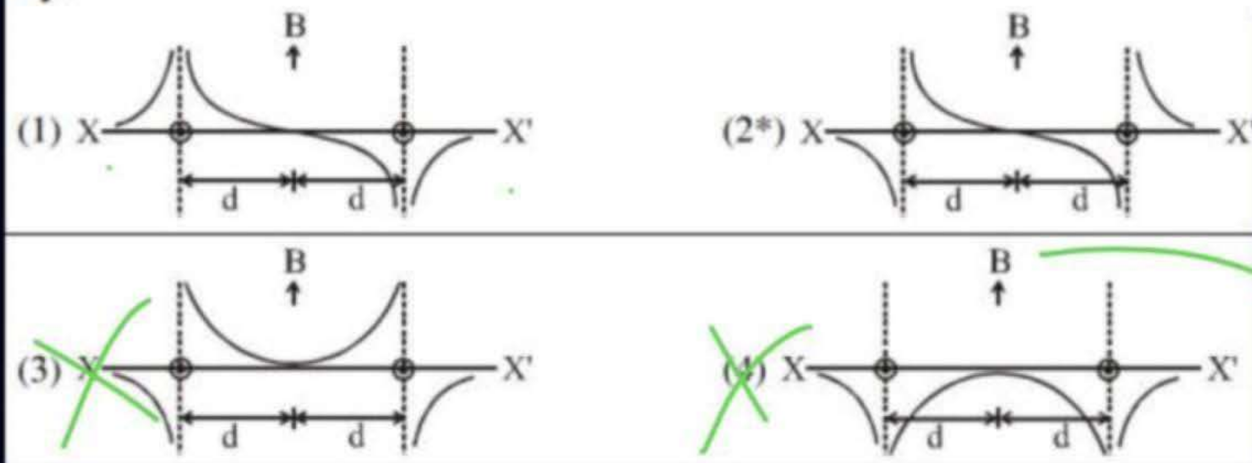
$$r = \frac{mv}{qB}$$

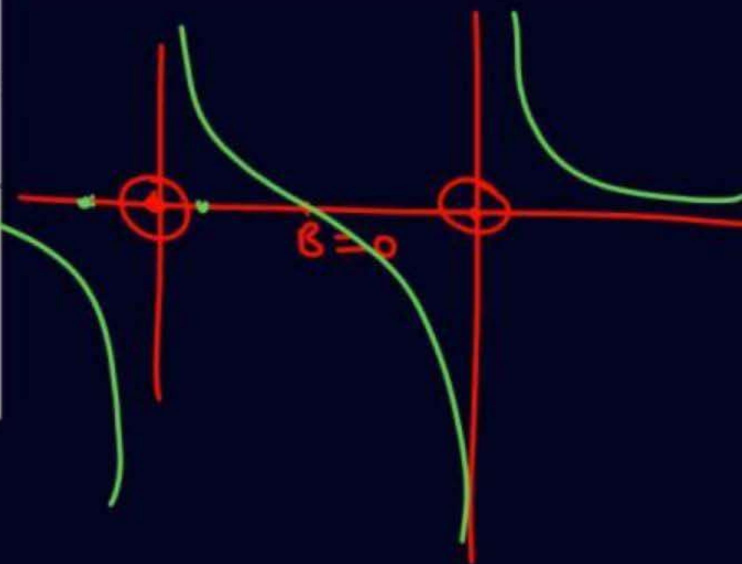
Ans : (B)

QUESTION

Two long parallel wires are at a distance 2d apart. They carry steady equal currents flowing out of the plane of the paper as shown. The variation of the magnetic field B along the line XX' is given by:-

[AIEEE - 2010]





Ans : (2)

QUESTION

$L = \frac{mR^2}{2}\omega$

A thin circular disk of radius R is uniformly charged with density $\sigma > 0$ per unit area. The disk rotates about its axis with a uniform angular speed ω. The magnetic moment of the disk is :-

$\vec{L} \cdot \frac{q}{2m}$

[AIEEE - 2011]

(1) $2\pi R^4 \sigma\omega$
(2) $\pi R^4 \sigma\omega$
(3) $\frac{\pi R^4}{2}\sigma\omega$
(4*) $\frac{\pi R^4}{4}\sigma\omega$

$q = \sigma \cdot \pi R^2$

$\frac{mR^2}{2}\omega \times \frac{q}{2m}$

Ans : (4)

QUESTION

5-6 mint

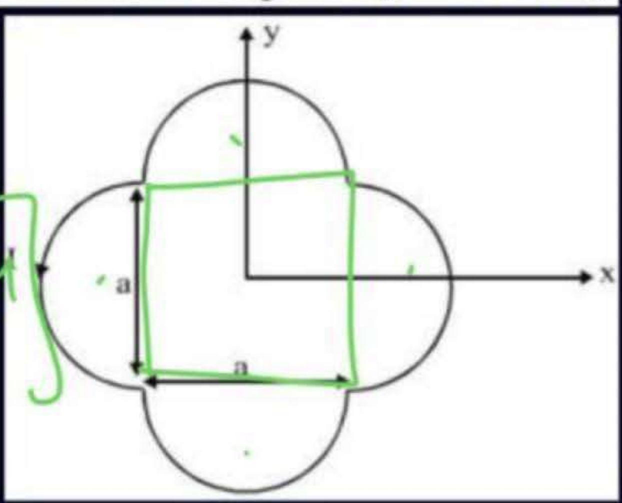
A loop carrying current 'I' lies in the x-y plane as shown in the figure. The unit vector $\hat{k}$ is coming out of the plane of the paper. The magnetic moment of the current loop is [JEE 2012]

(A) $a^2 I\hat{k}$

(B) $\left(\frac{\pi}{2}+1\right)a^2 I\hat{k}$

(C) $-\left(\frac{\pi}{2}+1\right)a^2 I\hat{k}$

(D) $(2\pi+1)a^2 I\hat{k}$



$$i \times \left[a^2 + \frac{\pi a^2}{2} \times 4\right]$$

Ans : (B)

EMI & AC

$$q\vec{E} + q(\vec{v}\times\vec{B}) = 0$$
$$\vec{E} = -(\vec{v}\times\vec{B})$$

$$\boxed{\begin{aligned}\Delta V &= -\int \vec{E}\cdot d\vec{l} \\ \Delta V &= (\vec{v}\times\vec{B})\cdot\vec{l}\end{aligned}}$$

* $\text{emf} = -\dfrac{d\phi}{dt}$ $\qquad i = \dfrac{\text{emf}}{R}$

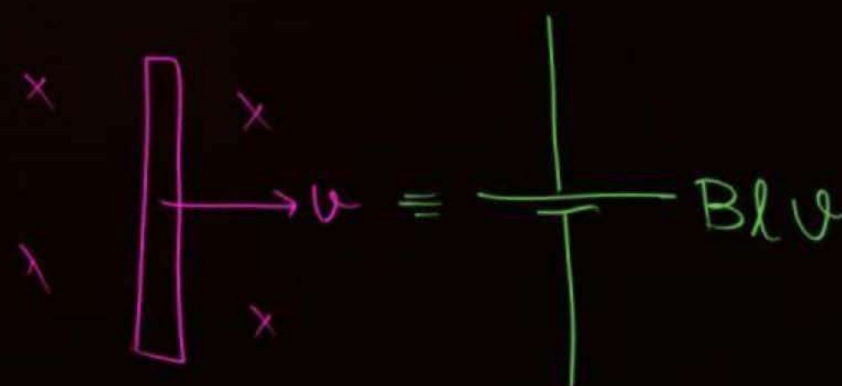
→ motional

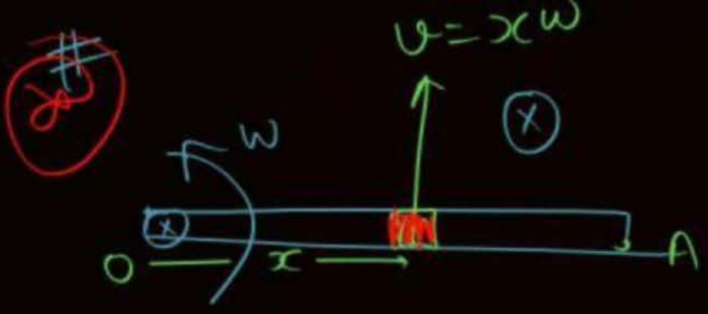
→ Time varying $\vec{B}$

$$\boxed{\oint \vec{E}\cdot d\vec{l} = A\,\frac{dB}{dt}}$$

flux

$i =$ ✓



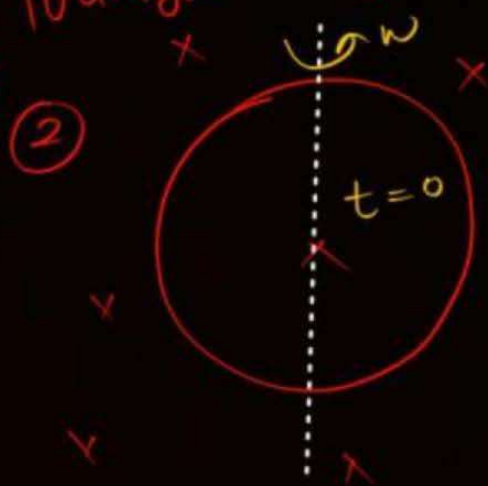


$$\int dE = \int_0^l x\omega \cdot dx \cdot B = \frac{B\omega l^2}{2}$$

$$\boxed{V_0 - V_A = \frac{1}{2} B\omega l^2}$$

10 बार पूछा गया है

(2)



$$\phi = N\vec{B}\cdot\vec{A} = NBA\cos\omega t$$

$$\boxed{\phi_{max} = NBA}$$

$$emf = \left|\frac{d\phi}{dt}\right| = \omega NBA\sin\omega t$$

$$(emf)_{max} = NBA\omega$$

$$i = \frac{\omega NBA\sin\omega t}{R}$$

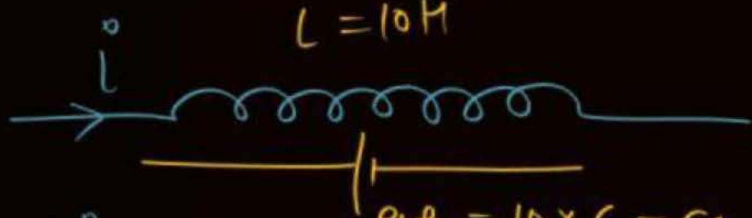
$$\boxed{i_{max} = \frac{\omega NBA}{R}}$$

$$\phi = Li$$

$$emf = -\frac{d\phi}{dt} = -L\frac{di}{dt}$$

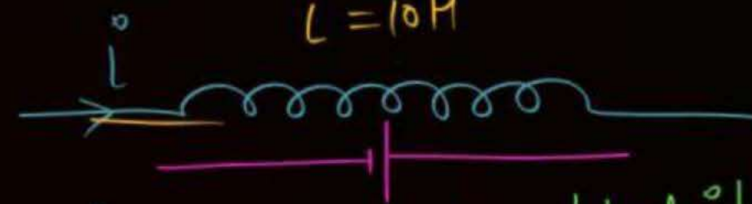
$$emf = -L\frac{di}{dt}$$

$$|emf| = \frac{L\,di}{dt}$$



$$\frac{di}{dt} = +6$$

emf $= 10 \times 6 = 60$



$$\frac{di}{dt} = -3$$

emf $= \left| L\frac{di}{dt} \right|$

$= 10 \times 3 = 30$

$$U = \frac{1}{2} L i^2$$

$$\frac{1}{2}\epsilon_0 E^2$$

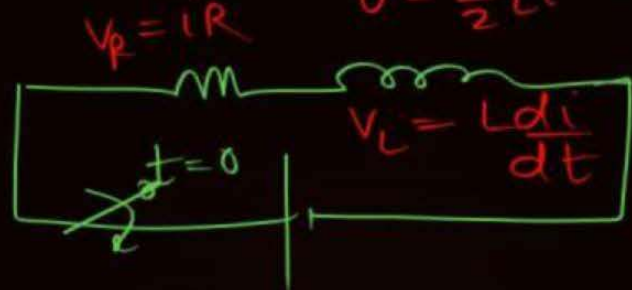
$$\frac{B^2}{2\mu_0}$$

R-L Circuit

$t=0$, inductor → wire
$t=\infty$, inductor → close wire

$U = \frac{1}{2}Li^2$

① Grow of Current



$i = i_0(1-e^{-t/\tau})$

$i = \frac{E}{R}(1-e^{-t/\tau})$

$\tau = \frac{L}{R}$

RL Decay

$i = i_0 e^{-t/\tau}$

$\phi_s = M i_p$

A.C

$i = i_0 \sin\omega t$

$i_{rms} = \frac{i_0}{\sqrt{2}}$

220V, 50 Hz

$V_{rms} = 220V$

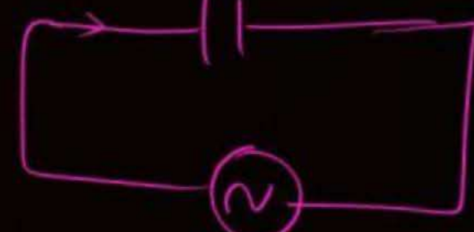
$E = 220 \sin\omega t$

$E_{max} = 220$

$E_{rms} = \frac{220}{\sqrt{2}}$

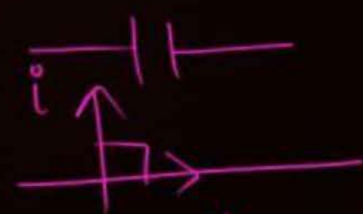
$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

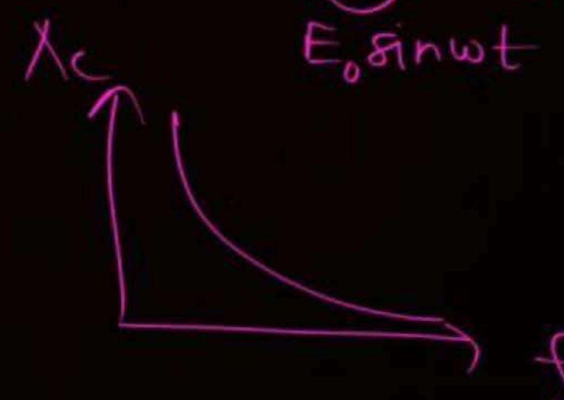
$i = \frac{E_0}{X_C} \sin(\omega t + 90)$



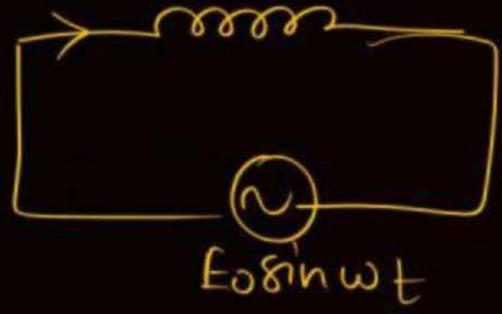
$E_0 \sin\omega t$

$$i_{rms} = \sqrt{\frac{\int_0^t i^2 dt}{\int_0^t dt}}$$





$$i = \frac{E_0}{X_L} \sin(\omega t - 90)$$

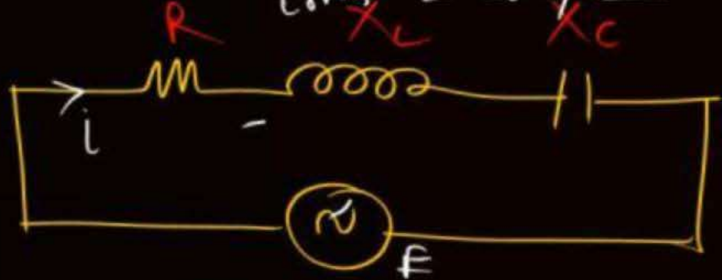


$$X_L = L\omega$$

RLC

$$i_{max} = \frac{E_{max}}{Z}$$

$$i_{rms} = E_{rms}/Z$$

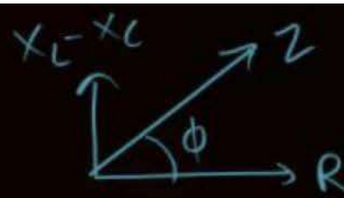


$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

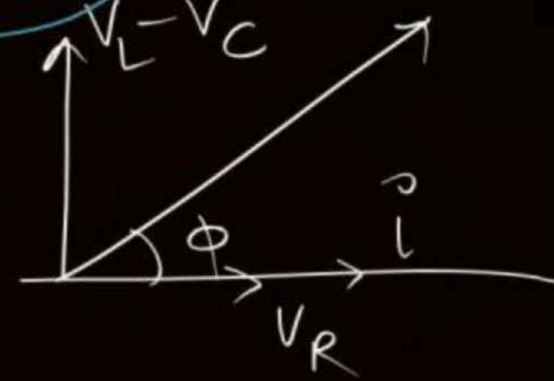
power factor $= \cos\phi = \frac{R}{Z}$

$$\boxed{\text{Power} = V_{rms}\, i_{rms} \cos\alpha}$$

Wattless current $= i_{rms} \sin\alpha$



$$\cos\phi = \frac{R}{Z}$$



$$\tan\phi = \frac{X_L - X_C}{R}$$

$$= \frac{V_L - V_C}{V_R}$$

$$= \frac{iX_L - iX_C}{iR} = \frac{X_L - X_C}{R}$$

Resonance

$P.F = 1$ $\quad Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(L 2\pi f - \frac{1}{2\pi f C}\right)^2}$

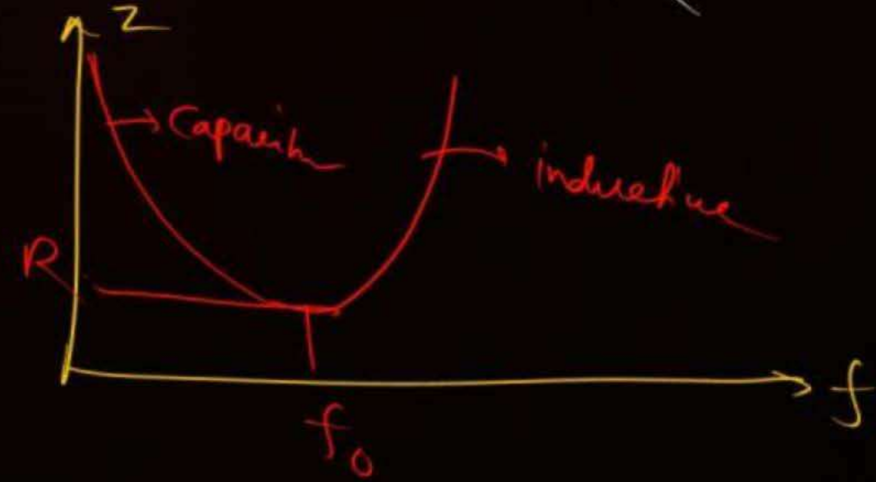
$\tan\phi = \frac{X_L - X_C}{R}$ $\quad X_L = X_C$ $\quad V_{net} = V_R$

$\phi = 0$ $\quad L\omega = \frac{1}{\omega C}$ $\quad Z = R$ = purely Resist $= Z_{min}$

$i_{max} = \frac{V_{max}}{Z} = \frac{V_{max}}{R}$

$\frac{2\pi}{T} = \omega = \frac{1}{\sqrt{LC}} = 2\pi f$

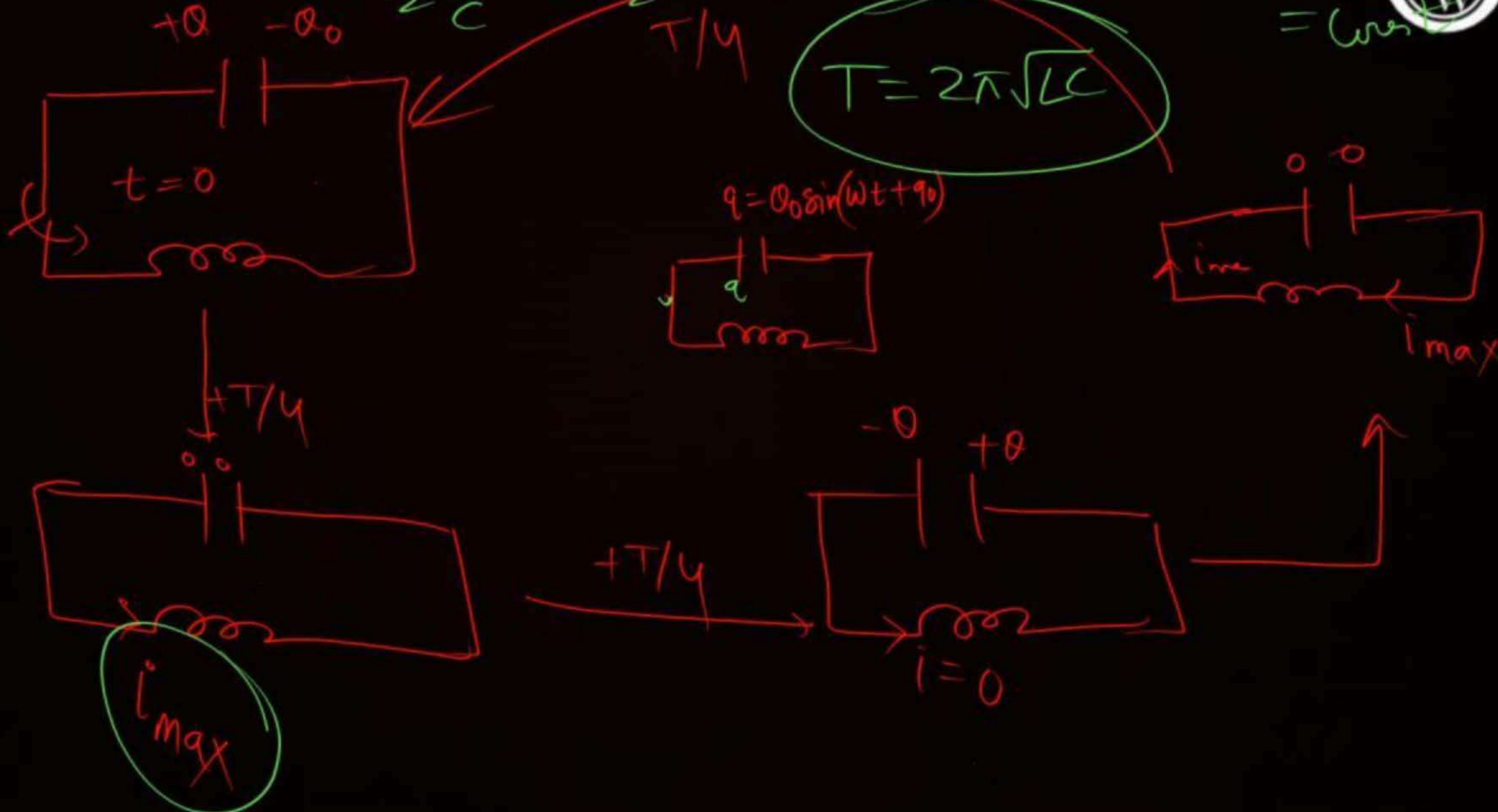
$$f_0 = \frac{1}{2\pi}\frac{1}{\sqrt{LC}}$$



$$\frac{1}{2}\frac{Q_0^2}{C} = \frac{1}{2}L i_{max}^2 = \frac{1}{2}\frac{q^2}{C} + \frac{1}{2}L i^2 = T.E = \text{Const}$$

$$T = 2\pi\sqrt{LC}$$

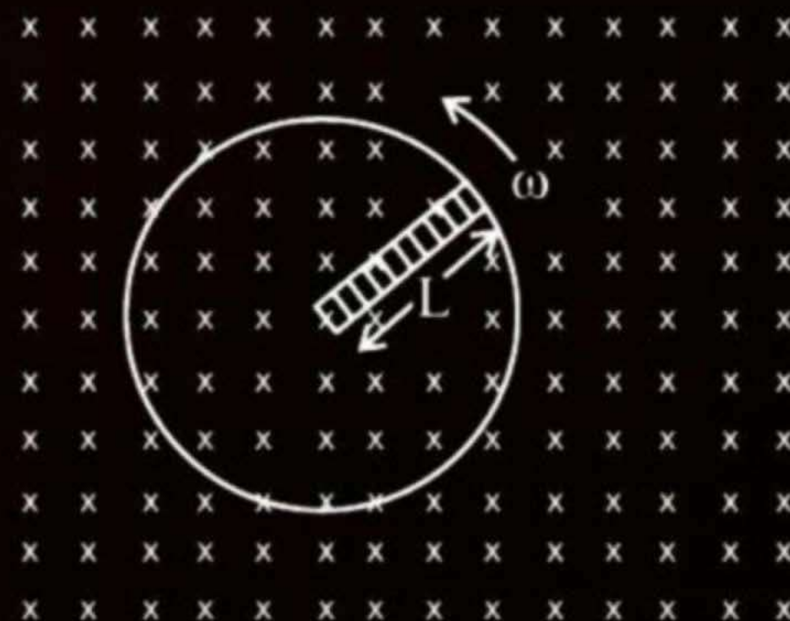
$$q = Q_0 \sin(\omega t + 90)$$



QUESTION

A metallic rod of length 'L' is rotated with an angular speed of 'ω' normal to a uniform magnetic field 'B' about an axis passing through one end of rod as shown in figure. The induced emf will be :

[24 January 2023 - Shift 2]



(1) $\frac{1}{4}B^2L\omega$

(2) $\frac{1}{4}BL^2\omega$

(3) $\frac{1}{2}BL^2\omega$

(4) $\frac{1}{2}B^2L^2\omega$

Ans : (3)

QUESTION

A wire of length 1 m moving with velocity 8 m/s at right angles to a magnetic field of 2 T. The magnitude of induced emf, between the ends of wire will be ______.

[25 January 2023 - Shift 2]

(1) 20 V

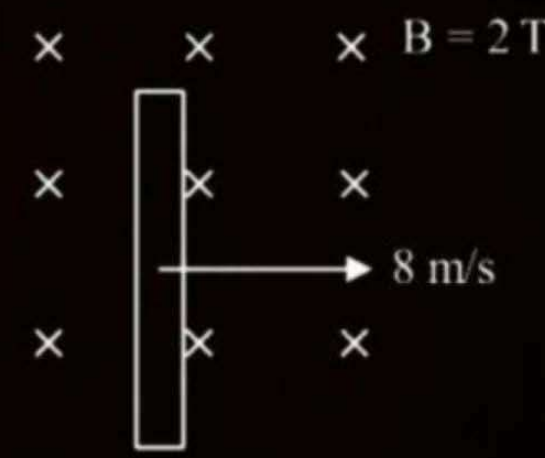
(2) 8 V

(3) 12 V

(4) 16 V

$= v l B$

$= 8 \times 1 \times 2$



Ans : (4)

QUESTION

A certain elastic conducting material is stretched into a circular loop. It is placed with its plane perpendicular to a uniform magnetic field $B = 0.8$ T. When released the radius of the loop starts shrinking at a constant rate of 2 cm^{-1}. The induced emf in the loop at an instant when the radius of the loop is 10 cm will be 10 mV.

$\phi = B\pi r^2$

[29 January 2023 - Shift 1]

$$\frac{d\phi}{dt} = B\pi 2r \frac{dr}{dt}$$

$$= .8 \times \pi \times 2 \times .1 \times 2 \times 10^{-2}$$

$$= 3.2 \times 3.14 \times 10^{-3}$$

Ans : (10)

QUESTION

As per the given figure, if $\frac{dI}{dt} = -1$ A/s then the value of V_{AB} at this instant will be ______ V.

[30 January 2023 - Shift 1]

$$V_A - 2\times 12 + 6 - 12 = V_B$$

$$V_A - V_B = 30$$

Ans : (30)

QUESTION

$$E_{rms} = 220 = \frac{E_0}{\sqrt{2}}$$

An inductor of 0.5 mH, a capacitor of 20 μF and resistance of 20 Ω are connected in series with a 220 V ac source. If the current is in phase with the emf, the amplitude of current of the circuit is $\sqrt{x}$ A. The value of x is – [31 January 2023 - Shift 1]

$$i_{max} = \frac{E_{max}}{Z} = \frac{E_{max}}{R}$$

$$i_{max} = \frac{220\sqrt{2}}{20} = \sqrt{x}$$

$$\boxed{\frac{220 \times 220 \times 2}{20 \times 20} = x}$$

Ans : (242)

QUESTION

The induced emf can be produced in a coil by

A. moving the coil with uniform speed inside uniform magnetic field

B. moving the coil with non uniform speed inside uniform magnetic field

C. rotating the coil inside the uniform magnetic field

D. changing the area of the coil inside the uniform magnetic field

Choose the correct answer from the options given below: [06 Apr 2023 - Shift 1]

(1) B and C only

(2) A and C only

(3) C and D only

(4) B and D only

Ans : (3)

QUESTION

For the plane electromagnetic wave given by $E = E_0 \sin(\omega t - kx)$ and $\boxed{B = B_0 \sin(\omega t - kx)}$, the ratio of average electric energy density to average magnetic energy density is

[06 Apr 2023 - Shift 1]

(1) $\frac{1}{2}$

(2) 2

(3) 4

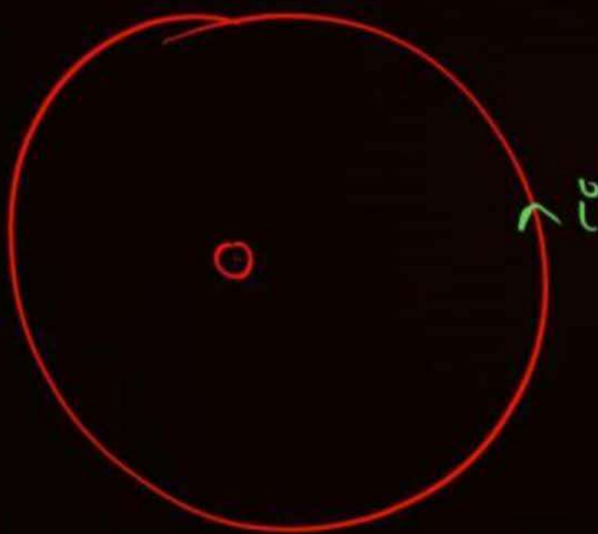
(4) 1

Ans : (4)

QUESTION

Two concentric circular coils with radii 1 cm and 1000 cm and number of turns 10 and 200 respectively are placed coaxially with centers coinciding. The mutual inductance of this arrangement will be ______ $\times 10^{-8}$ H. (Take, $\pi^2 = 10$)

[06 Apr 2023 - Shift 2]



$$M = \frac{\mu_0 N_1}{2R_{बड़ा}} \times \pi R^2_{छोटे} \times N_2$$

$$= \frac{4\pi \times 10^{-7} \times 10 \times \pi \times 10^{-4}}{2 \times 1000 \times 10^{-2}} \times 200$$

$$= 4 \times 10^{-8}$$

Ans : (4)

QUESTION

An emf of 0.08 V is induced in a metal rod of length 10 cm held normal to a uniform magnetic field of 0.4 T, when move with a velocity of: [08 Apr 2023 - Shift 2]

(1) 0.5 m s^{-1}

(2) 20 m s^{-1}

(3) 3.2 m s^{-1}

(4) 2 m s^{-1}

$$ef = Blv$$

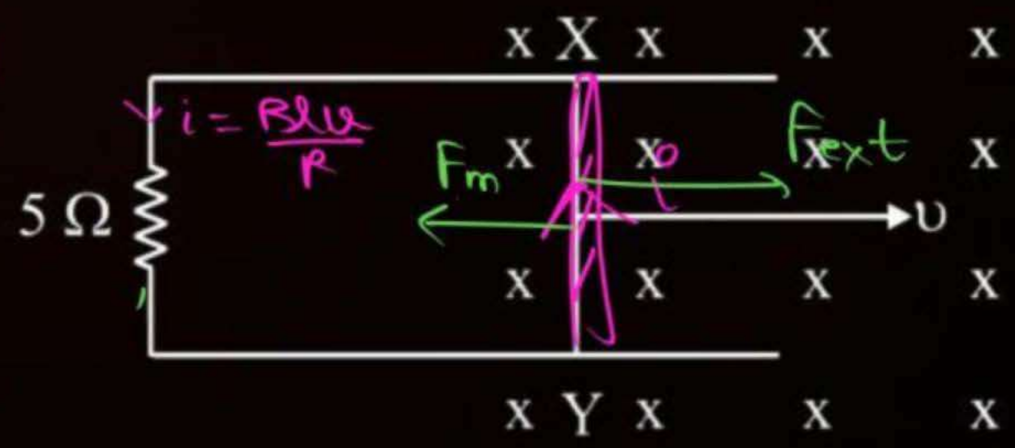
$$\frac{8}{100} = \frac{4}{10} \times \frac{10}{100} \times v$$

Ans : (4)

QUESTION

A 1 m long metal rod XY completes the circuit as shown in figure. The plane of the circuit is perpendicular to the magnetic field of flux density 0.15 T. If the resistance of the circuit is 5 Ω, the force needed to move the rod in direction, as indicated, with a constant speed of 4 m s^{-1} will be ______ 10^{-3} N. **[10 Apr 2023 - Shift 1]**

$$i l B = \frac{B^2 l^2 v}{R}$$



Ans :

QUESTION

The magnetic field B crossing normally a square metallic plate of area 4 m^2 is changing with time as shown in figure. The magnitude of induced emf in the plate during t = 2 s to t = 4 s, is ______ mV.

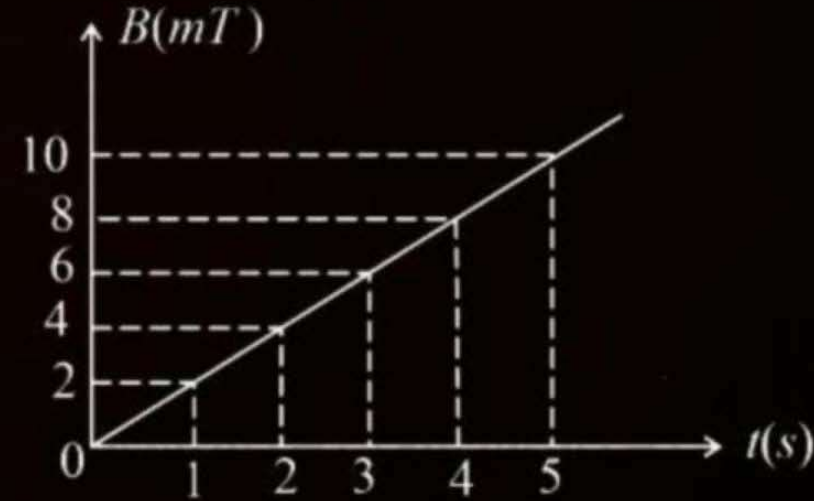
[11 Apr 2023 - Shift 1]

$B = 2t$

$\phi = 2t \times A$

$e_{ind} = \frac{d\phi}{dt} = 2A$

$= 2 \times 4$



Ans : (8)

QUESTION

A coil has an inductance of 2 H and resistance of 4 Ω. A 10 V is applied across the coil. The energy stored in the magnetic field after the current has built up to its equilibrium value will be ______ $\times 10^{-2}$ J

[11 Apr 2023 - Shift 2]

$$i = i_0\left(1 - e^{-t/\tau}\right)$$

$$t \to \infty$$

$$i = i_0 = \frac{\varepsilon}{R} = \frac{10}{4} =$$

$$\frac{1}{2}Li^2 = \boxed{\frac{1}{2} \times 2 \times \left(\frac{10}{4}\right)^2 \times 100} \times 10^{-2}$$

$$2.5 \times 2.5 \times 100$$

Ans : (625)

QUESTION

Repeat data ch

A conducting circular loop is placed in a uniform magnetic field of 0.4 T with its plane perpendicular to the field. Somehow, the radius of the loop starts expanding at a constant rate of 1 mm s^{-1}. The magnitude of induced emf in the loop at an instant when the radius of the loop is 2 cm will be ______ μV. **[12 Apr 2023 - Shift 1]**

$$\phi = B\pi R^2$$

$$e_{ind} = -\frac{d\phi}{dt} = B\pi 2R\frac{dR}{dt}$$

Ans : (50)

QUESTION

(*) try now

An insulated copper wire of 100 turns is wrapped around a wooden cylindrical core of the cross-sectional area 24 cm^2. The two ends of the wire are connected to a resistor. The total resistance in the circuit is $12\ \Omega$. If an externally applied uniform magnetic field in the core along its axis changes from 1.5 T in one direction to 1.5 T in the opposite direction, the charge flowing through a point in the circuit during the change of magnetic field will be __60__ mC.

[13 April 2023 - Shift 2]

$$\text{Charge flow} = \frac{\Delta\phi}{R} = \frac{2BAN}{R} = \frac{2 \times 1.5 \times \cancel{24}^{\,2} \times 10^{-4} \times 100}{\cancel{12}}$$

$$= 6 \times 10^{-2} = 60 \times 10^{-3}$$

Ans : (60)

QUESTION

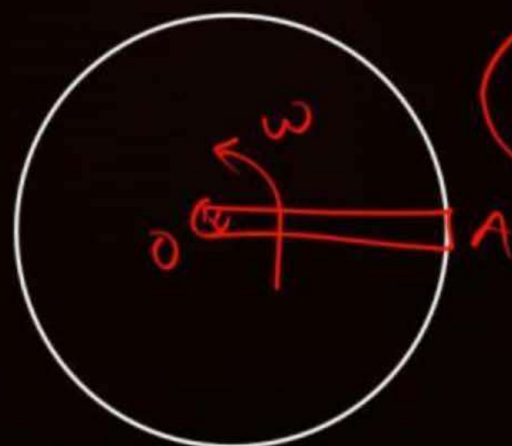
$\omega = 210 \times \frac{\pi}{30}$ rad/sec $= \frac{7 \times 22}{7} = 22$ rad/sec

A 20 cm long metallic rod is rotated with 210 rpm about an axis normal to the rod passing through its one end. The other end of the rod is in contact with a circular metallic ring. A constant and uniform magnetic field 0.2 T parallel to the axis exists everywhere. The emf developed between the centre and the ring is ______ mV.

(Take $\pi = \frac{22}{7}$)

[15 April 2023 - Shift 1]

$\frac{1}{2} B \omega \ell^2$

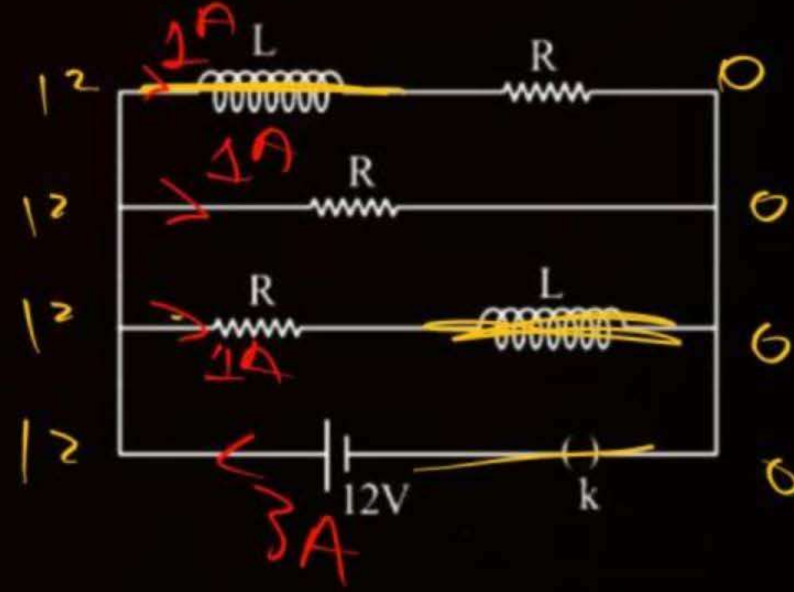


Ans : (88)

QUESTION

Three identical resistors with resistance R = 12 Ω and two identical inductors with sell inductance L = 5 mH are connected to an ideal battery with emf of 12 V as shown in figure. The current through the battery long after the switch has been closed will be ______A.

$t = \infty$ **[24 January 2023 - Shift 2]**



Ans : (3)

QUESTION

In an LC oscillator, if values of inductance and capacitance become twice and eight times, respectively, then the resonant frequency of oscillator becomes x times its initial resonant frequency ω_0. The value of x is: **[25 January 2023 - Shift 1]**

(1) 1/4

$$\omega = \frac{1}{\sqrt{LC}}$$

2 tim 8 tim

$$\frac{\omega}{4}$$

(2) 16

(3) 1/16

(4) 4

Ans : (1)

QUESTION

An LCR series circuit of capacitance 62.5 nF and resistance of 50 Ω. is connected to an A.C. source of frequency 2.0 kHz. For maximum value of amplitude of current in circuit, the value of inductance is ______ mH. (take $\pi^2 = 10$)

$\rightarrow Z_{min}$

[25 January 2023 - Shift 1]

(exact 1 year before)

$$X_L = X_C$$

$$L\omega = \frac{1}{\omega C}$$

$$L = \frac{1}{\omega^2 C} = \frac{1}{4\pi^2 f_0^2 C} = \frac{10^9}{4 \times 10 \times 2 \times 10^3 \times 2 \times 10^3 \times 62.5}$$

$$= \frac{100}{1000} = \frac{1000}{10} \times 10^{-3} = 100$$

Ans : (100)

QUESTION

$$\frac{R}{Z} = \frac{R}{\sqrt{R^2+(X_L-X_C)^2}} = \frac{80}{\sqrt{80^2+60^2}} = \frac{8}{10} = \frac{x}{10}$$

A series LCR circuit is connected to an AC source of 220 V, 50 Hz. The circuit contains a resistance R = 80 Ω, an inductor of inductive reactance X_L = 70 Ω, and a capacitor of capacitive reactance X_C = 130 Ω. The power factor of circuit is $\frac{x}{10}$. The value of x is :

[25 January 2023 - Shift 2]

$$\tan\alpha = \left|\frac{X_L-X_C}{R}\right| = \frac{60}{80}$$

$$\alpha = 37^\circ$$

$$\cos\alpha = 4/5$$

$$\frac{4}{5} = \frac{x}{10}$$

$$x = 8$$

Ans : (8)

QUESTION

Find the mutual inductance in the arrangement, when a small circular loop of wire of radius 'R' is placed inside a large square loop of wire of side L (L >> R). The loops are coplanar and their centres coincide:

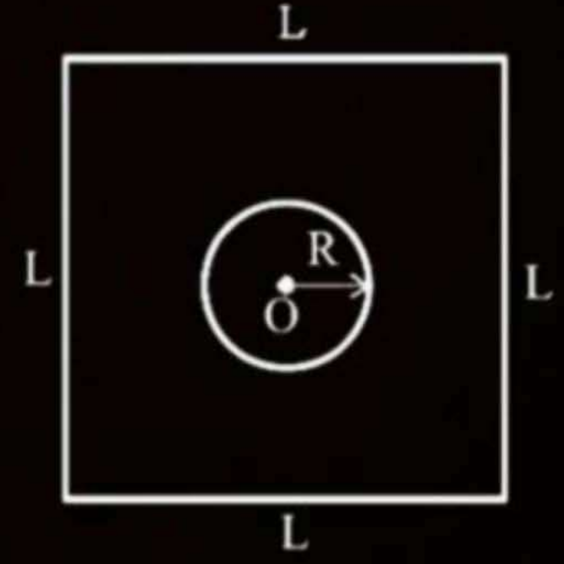
[29 January 2023 - Shift 1]

(1) $M = \frac{\sqrt{2}\mu_0 R^2}{L}$

(2) $M = \frac{2\sqrt{2}\mu_0 R}{L^2}$

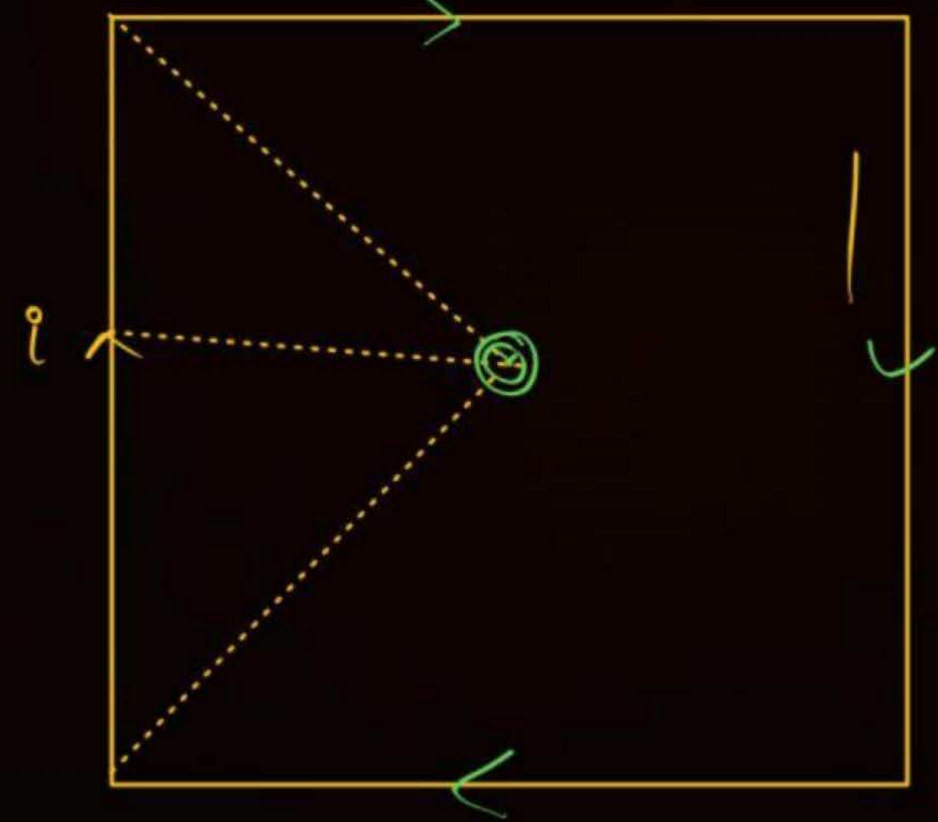
(3) $M = \frac{2\sqrt{2}\mu_0 R^2}{L}$

(4) $M = \frac{\sqrt{2}\mu_0 R}{L^2}$



Ans : (3)

ii



$$M = \frac{K}{l/2}\left(\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}\right)\pi r^2 \times 4$$

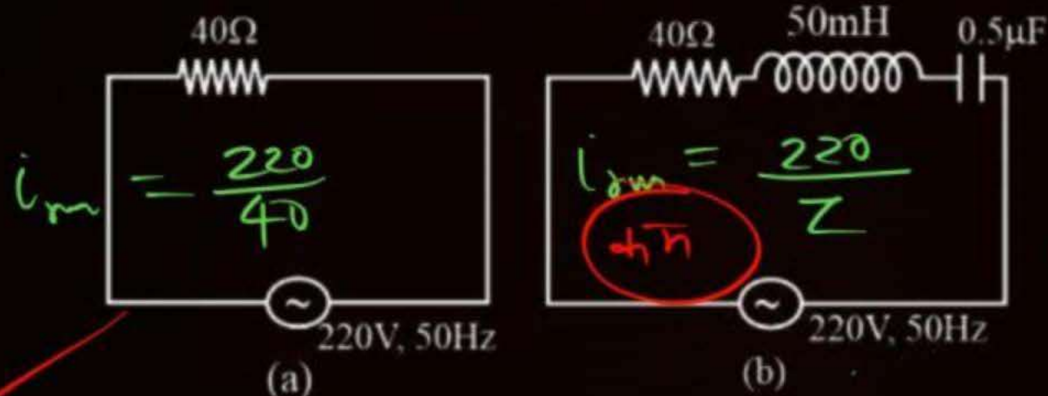
$$= \frac{2\sqrt{2}\,\mu_0 r^2}{l x}$$

QUESTION JA

$X_L = 50\times10^{-3}\times 2\pi 50 = 5\pi$

$X_C = \frac{1}{\omega C} = \frac{10^6\times 10}{2\pi\, 50\times 5} = \frac{10^7}{500\pi}$

For the given figures, choose the correct options: **[29 January 2023 - Shift 2]**



$Z = \sqrt{40^2 + (X_L - X_C)^2}$

$Z > R$

1. The rms current in circuit (b) can never be larger than that in (a)
2. The rms current in figure (a) is always equal to that in figure (b)
3. The rms current in circuit (b) can be larger than that in (a)
4. At resonance, current in (b) is less than that in (a) — same

Ans : (1)

QUESTION

An inductor of inductance 2 μH is connected in series with a resistance, a variable capacitor and an AC source of frequency 7 kHz. The value of capacitance for which maximum current is drawn into the circuit is $\frac{1}{x}$ F, where the value of x is ______.

(Take $\pi = \frac{22}{7}$)

$X_L = X_C$

$C = \frac{1}{\omega L \omega} = \underline{Ans}$

[29 January 2023 - Shift 2]

Ans : (3872)

QUESTION

$Z = R\sqrt{2}$ $\cos\alpha = \frac{R}{Z} = \frac{R}{R\sqrt{2}} = \frac{1}{\sqrt{2}}$

In a series LR circuit with $X_L = R$. power factor is P_1. If a capacitor of capacitance C with $X_C = X_L$ is added to the circuit the power factor becomes P_2. The ratio of P_1 to P_2 will be :

[30 January 2023 - Shift 1]

$\rightarrow$ Res. $\cos\alpha = 1$

1. $1:3$
2. $1:\sqrt{2}$
3. $1:1$
4. $1:2$

Ans : (2)

QUESTION

In the given circuit, rms value of current (I_{rms}) through the resistor R is :

[30 January 2023 - Shift 2]

(1) 2 A

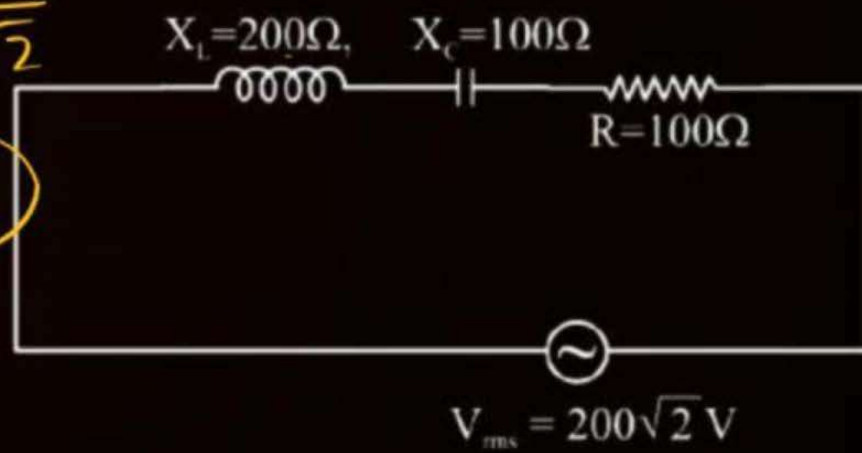
(2) $\frac{1}{2}$ A

(3) 20 A

(4) $2\sqrt{2}$ A

$$\frac{V_{rms}}{Z} = \frac{200\sqrt{2}}{100\sqrt{2}}$$

$$= 2$$



Ans : (1)

QUESTION

rpm

In an ac generator, a rectangular coil of 100 turns each having area $14 \times 10^{-2}\ m^2$ is rotated at 360 rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be _______ V.

(Take $\pi = \frac{22}{7}$)

[30 January 2023 - Shift 2]

NBAW

$\omega = 360 \times \frac{\pi}{30}$

$= 12\pi$

$\cancel{100} \times 3 \times \cancel{14} \times \cancel{10^{-2}} \times 12 \times \frac{22}{\cancel{7}}$

2

$$\begin{array}{r} 72 \\ 22 \\ \hline 144 \\ 144 \\ \hline 1584 \end{array}$$

Ans : (1584)

QUESTION

An alternating voltage source V = 260sin(628t) is connected across a pure inductor of 5 mH. Inductive reactance in the circuit is: [31 January 2023 - Shift 2]

$$X_L = L\omega = 5\times10^{-3}\times 628$$
$$= 3.140$$

(1) 3.14 Ω

(2) 6.28 Ω

(3) 0.5 Ω

(4) 0.318 Ω

Ans : (1)

QUESTION

A series LCR circuit consists of R = 80 Ω X_L = 100 Ω, and X_C = 40 Ω The input voltage is 2500cos(100πt) V. The amplitude of current, in the circuit, is ______ A.

[31 January 2023 - Shift 2]

$$i_{max} = \frac{V_{max}}{Z} = \frac{2500}{100} = 25$$

Ans : (25)

QUESTION

A capacitor of capacitance 150.0 μF is connected to an alternating source of emf given by $E = 36\sin(120\pi t)$V. The maximum value of current in the circuit is approximately equal to: [06 April 2023 - Shift 2]

(1) 2 A   approx

(2) $\sqrt{2}$ A   2.034

(3) $2\sqrt{2}$ A

(4) $\frac{1}{\sqrt{2}}$ A

$$I_{max} = \frac{36}{X_C} = 36\,\omega C$$

$$= 36 \times 120\pi \times 150 \times 10^{-6}$$

$$\approx 2000000 \times 10^{-6}$$

Ans : (1)

QUESTION

An oscillating LC circuit consists of a 75 mH inductor and a 1.2 μF capacitor. If the maximum charge to the capacitor is 2.7 μC. The maximum current in the circuit will be ______ mA.

[08 April 2023 - Shift 1]

$$\frac{1}{2}\frac{Q_0^2}{C} = \frac{1}{2}L i_{max}^2$$

$$i_{max} = \sqrt{\frac{Q_0^2}{LC}} = \frac{Q_0}{\sqrt{LC}} = Q_0\omega$$

SHM

$v_{max} = A\omega$

$i_{max} = Q\omega$

Ans : (9)

QUESTION

$P = V_{rms} \, i_{rms} \cos\alpha$

Given below are two statements:

Statement I: Maximum power is dissipated in a circuit containing an inductor, a capacitor and a resistor connected in series with an AC source, when resonance occurs.

$\cos\alpha = 1$

Statement II: Maximum power is dissipated in a circuit containing pure resistor due to zero phase difference between current and voltage.

In the light of the above statements, choose the correct answer from the options given below:

[10 April 2023 - Shift 1]

1. Statement I is false but Statement II is true
2. Both Statement I and Statement II are true
3. Statement I is true but Statement II is false
4. Both Statement I and Statement II are false

Ans : (2)

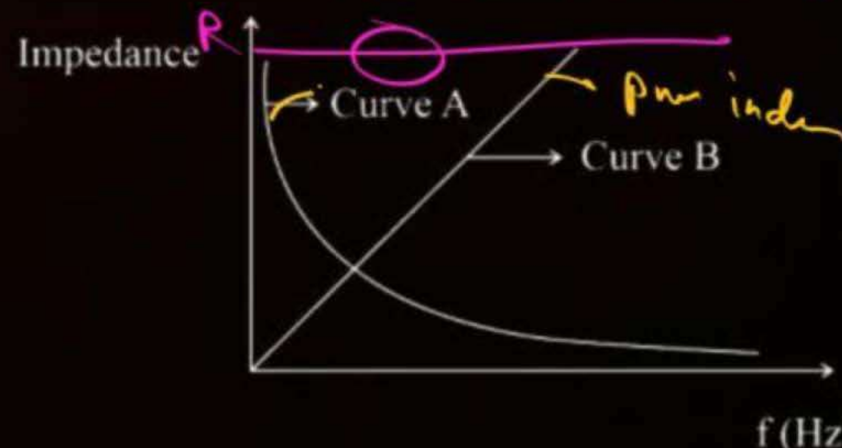
QUESTION

As per the given graph, choose the correct representation for curve A and curve B {Where X_C = Reactance of pure capacitive circuit connected with A.C. source X_L = Reactance of pure inductive circuit connected with A.C. source R = Impedance of pure resistive circuit connected with A.C. source Z = Impedance of the LCR series circuit}

[11 April 2023 - Shift 1]

$X_L = L\omega$

$X_L = L 2\pi f$



(1) $A = X_C, B = R$

(2) $A = X_L, B = R$

(3) $A = X_L, B = Z$

(4) $A = X_C, B = X_L$

Ans : (4)

QUESTION

$$i = \frac{BNA\omega}{R} \sin \omega t$$

Given below are two statements:

Statement I: When the frequency of an AC source in a series LCR circuit increases, the current in the circuit first increases, attains a maximum value and then decreases.

Statement II: In a series LCR circuit, the value of power factor at resonance is one.

In the light of given statements, choose the most appropriate answer from the options given below. **[12 April 2023 - Shift 1]**

(1) Statement I is incorrect but Statement II is true

(2) Both Statement I and Statement II are false

(3) Both Statement I and Statement II are true

(4) Statement I is correct but Statement II is false

Ans : (3)

QUESTION

R, X_L, X_C

Given below are two statements:

Statement I: An AC circuit undergoes electrical resonance if it contains either a capacitor or an inductor.

Statement II: An AC circuit containing a pure capacitor or a pure inductor consumes high power due to its non-zero power factor. $\rightarrow \phi = 90$ $P_{av} = 0$

In the light of above statements, choose the correct answer from the options given below:

[13 April 2023 - Shift 2]

(1) Statement I is false but statement II is true

(2) Statement I is true but statement II is false

(3) Both Statement I and Statement II are false

(4) Both Statement I and Statement II are true

Ans : (3)

QUESTION

exam में last में करने होते हैं

An emf of 20 V is applied at time $t = 0$ to a circuit containing in series 10 mH inductor and 5 Ω resistor. The ratio of the currents at time $t = \infty$ and at $t = 40$ s is close to : (Take $e^2 = 7.389$) [JEE Main-2020]

$i_1 = \varepsilon/R$

$i_2 = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$

$\frac{i_1}{i_2} = \frac{1}{1 - e^{-t/\tau}}$

$\tau = \frac{L}{R}$

(1) 1.06

(2) 1.15

(3) 1.46

(4) 0.84

Ans : (1)

QUESTION

At time $t = 0$ magnetic field of 1000 Gauss is passing perpendicularly through the area defined by the closed loop shown in the figure. If the magnetic field reduces linearly to 500 Gauss, in the next 5s, then induced EMF in the loop is:

[JEE Main-2020]

(1) $36\ \mu V$

(2) $48\ \mu V$

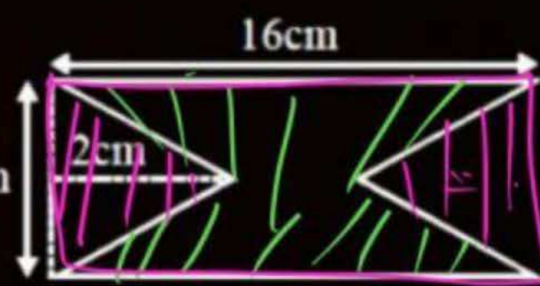
(3) $56\ \mu V$

(4) $28\ \mu V$

$\frac{\Delta B}{\Delta t} = 100$ gau

$emf = \frac{d\phi}{dt} = A \frac{dB}{dt}$

$=$



$A = 64 - \frac{1}{2} 4 \times 2 \times 2$

$= 56$

Ans : (3)

QUESTION

An inductance coil has a reactance of 100 Ω. When an AC signal of frequency 1000 Hz is applied to the coil, the applied voltage leads the current by 45°. The self-inductance of the coil is:

[JEE Main-2020]

(1) 1.1×10^{-2} H

(2) 1.1×10^{-1} H

(3) 5.5×10^{-5} H

(4) 6.7×10^{-7} H

$\phi = 45$

$\cos 45 = \frac{R}{Z}$

$\frac{1}{\sqrt{2}} = \frac{R}{100}$

$R = \frac{100}{\sqrt{2}}$

$Z = 100 = \sqrt{R^2 + X_L^2}$

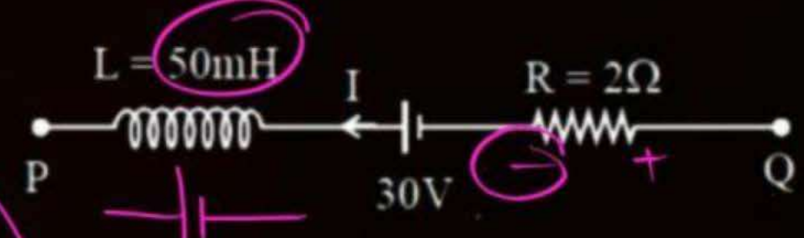
$(100)^2 = \frac{(100)^2}{2} + X_L^2$

Ans : (1)

QUESTION

A part of a complete circuit is shown in the figure. At some instant, the value of current I is 1A and it is decreasing at a rate of $10^2\,\mathrm{A\,s^{-1}}$. The value of the potential difference $V_P - V_Q$, (in volts) at that instant, is. **[JEE Main-2020]**

33



$$V_Q - 1\times 2 + 30 + 5 = V_P$$

$$50\times 10^{-3}\times 100 = 5\text{V}$$

$$V_P - V_Q = 33$$

Ans : (33.00)

QUESTION

$\cos\alpha = \frac{R}{Z} = .8$ $\boxed{R = .8Z}$

In a series LR circuit, power of 400W is dissipated from a source of 250V, 50 Hz. The power factor of the circuit is 0.8. In order to bring the power factor to unity, a capacitor of value C is added in series to the L and R. Taking the value of C as $\left(\frac{n}{3\pi}\right)$ μF, then value of n is ______.

[JEE Main-2020]

$P = i_{rms} V_{rms} \cos\alpha$

$400 = \frac{250}{Z} \times 250 \times .8$

$Z = \checkmark$

$R = \checkmark$

$= X_L$

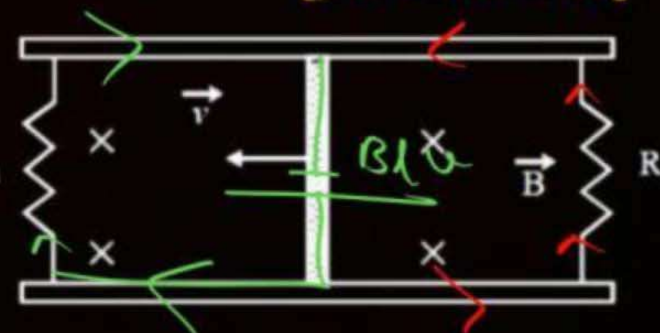
$X_L = X_C = \frac{1}{\omega C}$

Ans : (400.00)

QUESTION

A conducting bar of length L is free to slide on two parallel conducting rails as shown in the figure. Two resistors R_1 and R_2 are connected across the ends of the rails. There is a uniform magnetic field $\vec{B}$ pointing into the page. An external agent pulls the bar to the left at a constant speed v. The correct statement about the directions of induced currents I_1 and I_2 flowing through R_1 and R_2 respectively is :

[JEE Main-2021]



(1) Both I_1 and I_2 are in anticlockwise direction

(2) Both I_1 and I_2 are in clockwise direction

(3) I_1 is in clockwise direction and I_2 is in anticlockwise direction

(4) I_1 is in anticlockwise direction and I_2 is in clockwise direction

Ans : (3)

QUESTION

An AC current is given by $I = I_1 \sin\omega t + I_2 \cos\omega t$. A hot wire ammeter will give a reading :

[JEE Main-2021]

I_{rms}

(1) $\sqrt{\frac{I_1^2 - I_2^2}{2}}$

(2) $\sqrt{\frac{I_1^2 + I_2^2}{2}}$

(3) $\frac{I_1 + I_2}{\sqrt{3}}$

(4) $\frac{I_1 + I_2}{2\sqrt{2}}$

$= a \sin\omega t + b \cos\omega t$

$I = \sqrt{a^2 + b^2} \sin(\omega t + \alpha)$

$I_{rms} = \frac{\sqrt{a^2 + b^2}}{\sqrt{2}}$

Ans : (2)

QUESTION

A series LCR circuit of $R = 5\Omega$, $L = 20$ mH and $C = 0.5$ μF is connected across an AC supply of 250V, having variable frequency. The power dissipated at resonance condition is ______ $\times 10^2$ W.

[JEE Main-2021]

$$P = V_{rms}\, i_{rms} \cos 0$$

$$= V_{rms} \cdot \frac{V_{rms}}{R}$$

Ans : (125)

QUESTION

Match List-I with List-II :

[JEE Main-2021]

Choose the correct answer from the options given below :

	List–I		List–II
(a)	$\omega L > \frac{1}{\omega C}$	(i)	Current is in phase with emf
(b)	$\omega L = \frac{1}{\omega C}$	(ii)	Current lags behind the applied emf
(c)	$\omega L < \frac{1}{\omega C}$	(iii)	Maximum current occurs
(d)	Resonant frequency	(iv)	Current leads the emf

1. (a)–(ii); (b)–(i); (c)-(iv); (d)–(iii)
2. (a)–(ii); (b)–(i); (c)-(iii); (d)–(iv)
3. (a)–(iii); (b)–(i); (c)-(iv); (d)–(ii)
4. (a)–(iv); (b)–(iii); (c)-(ii); (d)–(i)

Ans : (1)

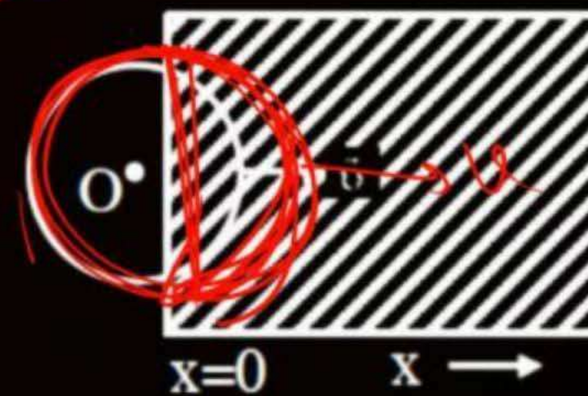
QUESTION

Maza!!

A constant magnetic field of $1T$ is applied in the $x > 0$ region. A metallic circular ring of radius 1m is moving with a constant velocity of 1 m/s along the x-axis. At $t = 0$s, the centre of O of the ring is at $x = -1$m. What will be the value of the induced emf in the ring at $t = 1$s? (Assume the velocity of the ring does not change.)

[JEE Main-2021]

$emf = B\,2R\,v$



(1) 1 V

(2) 2π V

(3) 2 V

(4) 0 V

Ans : (3)

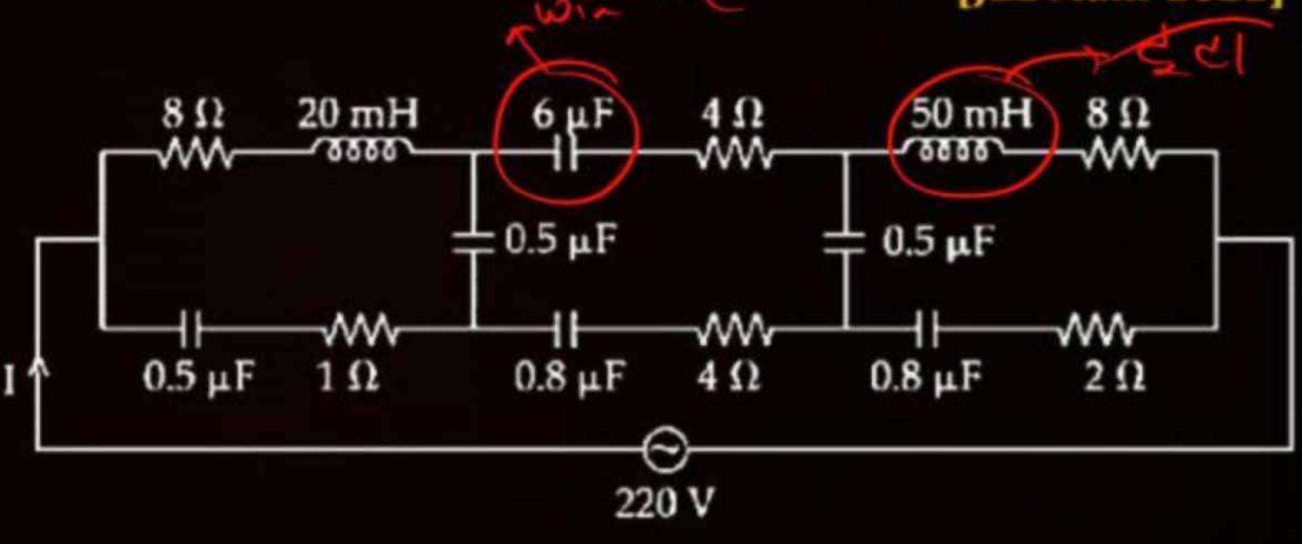
QUESTION

$f \rightarrow \infty$ $X_L \rightarrow \infty$

The effective current I in the given circuit at very high frequencies will be _____ A.

$X_C \rightarrow 0$

[JEE Main-2022]



Ans : (44)

QUESTION

A horizontal wire is free to slide on the vertical rails of a conducting frame as shown in figure. The wire has a mass m and length l and the resistance of the circuit is R. If a uniform magnetic field B is directed perpendicular to the frame, then find the terminal speed of the wire as it falls under the force of gravity.

$F_{net} = 0$

$$i l B = mg$$

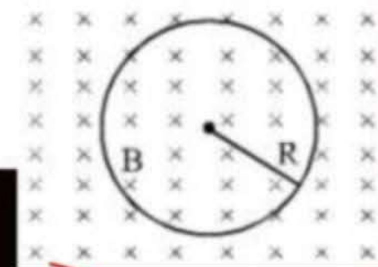
$$\frac{B l v}{R} l B = mg$$

Ans. $\frac{mgR}{B^2 \ell^2}$

QUESTION

A conducting loop of radius R is present in a uniform magnetic field B perpendicular to the plane of the ring. If radius R varies as a function of time 't', as $R = R_0 + t$. The e.m.f induced in the loop is

$\phi = B\pi(R_0+t)$



(A) $2\pi(R_0 + t)B$ clockwise

(B) $\pi(R_0 + t)B$ clockwise

(C*) $2\pi(R_0 + t)B$ anticlockwise

(D) zero

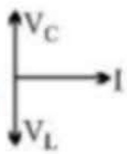
$emf = \frac{d\phi}{dt}$

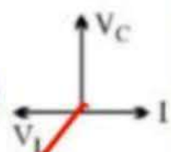
$= B\pi\, 2(R_0+t)$

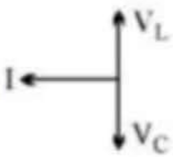
Ans : (C)

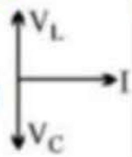
QUESTION

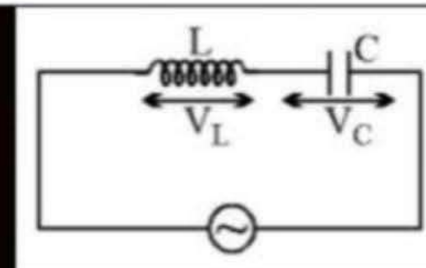
The current I, potential difference V_L across the inductor and potential difference V_C across the capacitor in circuit as shown in the figure are best represented vectorially as

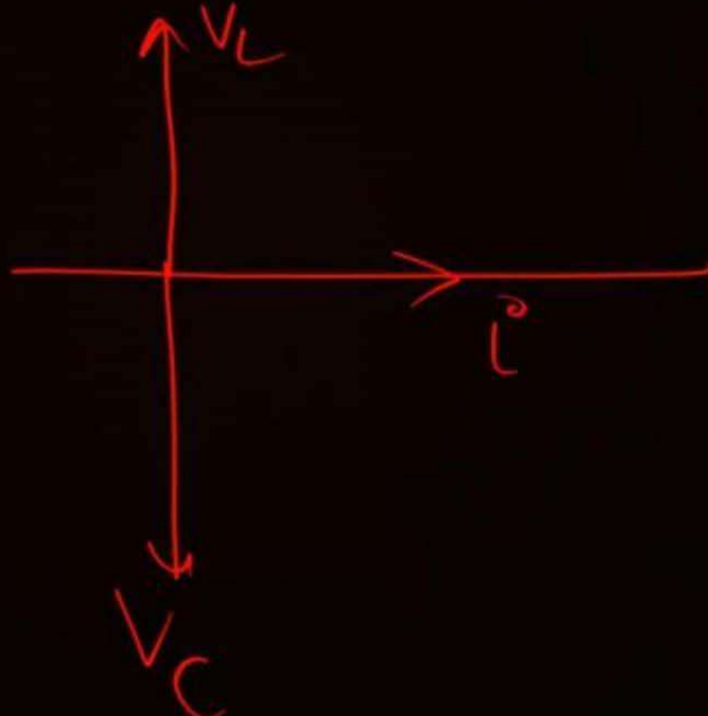
(A) 

(B) 

(C) 

(D*) 

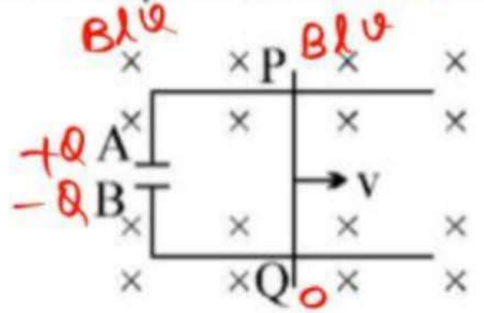




Ans : (D)

QUESTION

A conducting rod PQ of length $L = 1.0$ m is moving with a uniform speed $v = 20$ m/s in a uniform magnetic field $B = 4.0$ T directed into the paper. A capacitor of capacity $C = 10\ \mu F$ is connected as shown in figure. Then



(A*) $q_A = +800\mu C$ and $q_B = -800\mu C$

(B) $q_A = -800\mu C$ and $q_B = +800\mu C$

(C) $q_A = 0 = q_B$

(D) charge stored in the capacitor increases exponentially with time

$Q = C \times Bl v$

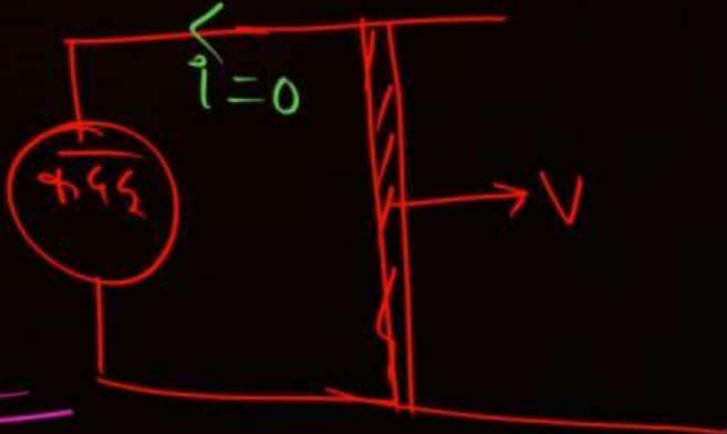
$i \longrightarrow 0$

R.B may be

(3) diode (1) Capac

(2) Voltmete

ideal



Ans : (A)

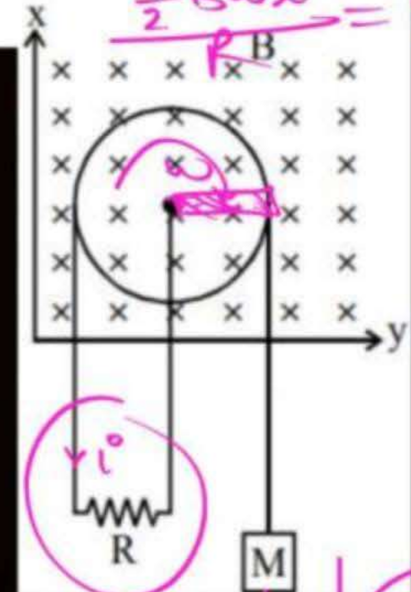
QUESTION

The block of mass (M) is connected by thread which is wound on a pulley, free to rotate about fixed horizontal axis as shown. A uniform magnetic field B exists in a horizontal plane. The disc is connected with the resistance R as shown. Calculate the terminal velocity of the block if it was released from rest. Treat pulley as uniform metallic disc of radius L.

(A) $\frac{4mgR}{B^2L^2}$ (B) $\frac{3mgR}{4B^2L^2}$ (C) $\frac{2mgR}{B^2L^2}$ (D) $\frac{3mgR}{2B^2L^2}$

$$\frac{\frac{1}{2}B\omega l^2}{R} = i$$

$$mgv = i^2 R$$



Ans : (A)

2nd Linc generate = 7:15pm

JW channel पर

1. emw
2. semi
3. modern
4. optics
   - wave
   - ray