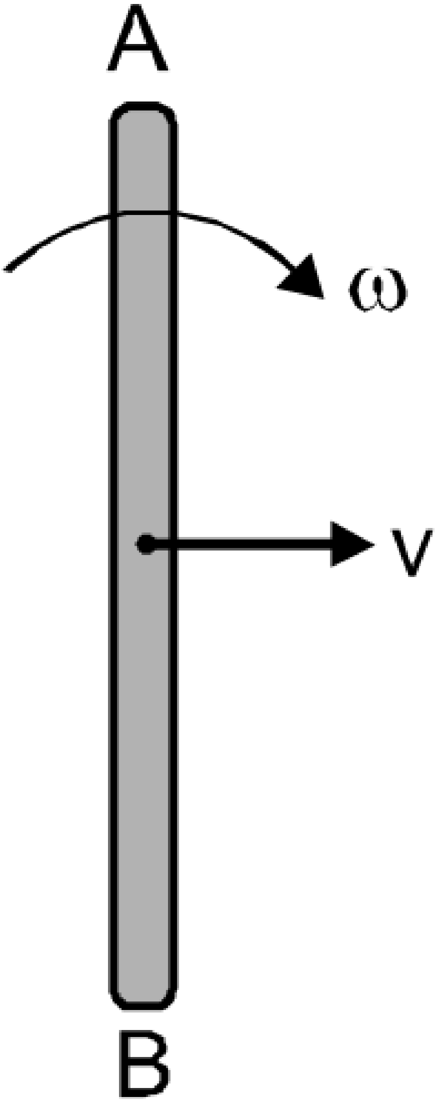
Q-1 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A metal rod of length , moving with an angular velocity ω and velocity of its centre is v. Find potential difference between points A and B at the instant shown in figure. A uniform magnetic field of strength B exist perpendicular to plane of paper



(A) Bvl

(B) $Bvl + \frac{1}{2}B\omega l^2$

(C) $Bvl - \frac{1}{2}B\omega l^2$

(D) $Bvl + B\omega\left(\frac{l}{2}\right)^2$

Correct Option : A

SOLUTION

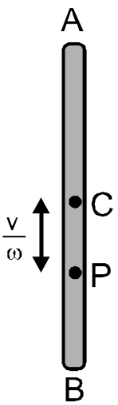
Point P is at instantaneous rest,

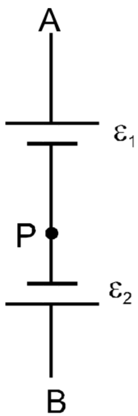
$$\varepsilon_1 = |v_P - v_A| = \frac{1}{2}B\omega\left(\frac{l}{2} + \frac{v}{\omega}\right)^2$$

$$\varepsilon_2 = |v_P - v_B| = \frac{1}{2}B\omega\left(\frac{l}{2} - \frac{v}{\omega}\right)^2$$

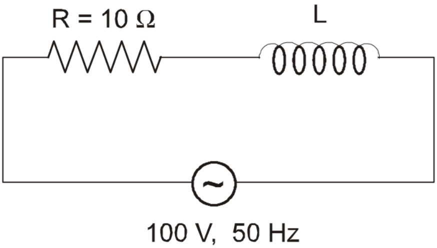
$$|v_A - v_B| = \varepsilon_1 - \varepsilon_2$$

$$|v_A - v_B| = Blv$$





In LR circuit (shown in figure), current is lagging by $\frac{\pi}{3}$ in phase with applied voltage, then select correct alternative:



(A) $L = \frac{10}{\sqrt{3}\pi} H, i = 10A$

(B) $L = \frac{10}{\pi} H, i = 5A$

(C) $L = \frac{10}{\sqrt{3}\pi} H, i = 5A$

(D) $L = \frac{\sqrt{3}}{10\pi} H, i = 5A$

Correct Option : D

SOLUTION

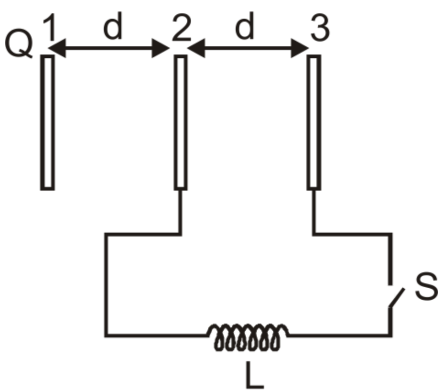
$$\frac{X_L}{R} = \sqrt{3} \Rightarrow x_L = R\sqrt{3}$$

$$i=\frac{100}{\sqrt{\left(10\sqrt{3}\right)^2+(10)^2}}=5A$$

$$L=\frac{10\sqrt{3}}{100\pi}=\frac{\sqrt{3}}{10\pi}H$$

Q-3 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

Three identical large plates are fixed at separation of d from each other as shown in figure. The area of each plate is A. Plate 1 is given charge $+Q$ while plates 2 and 3 are neutral and are connected to each other through coil of inductances L and switch S. If resistance of all connected wires is neglected the maximum current flow through coil after closing switch is ($C=\varepsilon e_0\frac{A}{d}$) (neglect fringe effect)



(A) $\frac{Q_0}{\sqrt{LC}}$

(B) $\frac{Q_0}{\sqrt{2LC}}$

(C) $\frac{2Q_0}{\sqrt{LC}}$

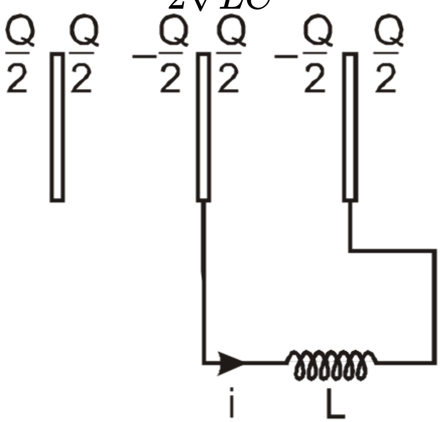
(D) $\frac{Q_0}{2\sqrt{LC}}$

Correct Option : D

SOLUTION

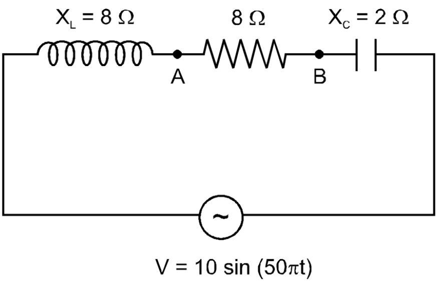
$$\frac{\left(\frac{Q}{2}\right)^2}{2C} = \frac{1}{2}Li_0^2$$

$$\Rightarrow I_0 = \frac{Q}{2\sqrt{LC}}$$



Q-4 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

The instantaneous potential differece between points A and B is :



(A) $8\sin\left(50\omega t+37\frac{\pi}{180}\right)$

(B) $8\sin\left(50\pi t-37\frac{\pi}{180}\right)$

(C) $10\sin(50\pi t)$

(D) $10\cos(50\pi t)$

Correct Option : B

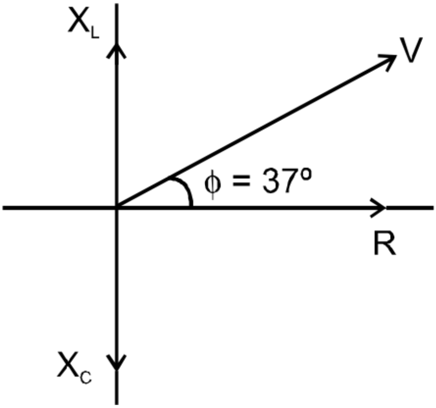
SOLUTION

Impedence $z=\sqrt{(8-2)^2+(8)^2}=10\Omega$

Current lags voltage by 37, then

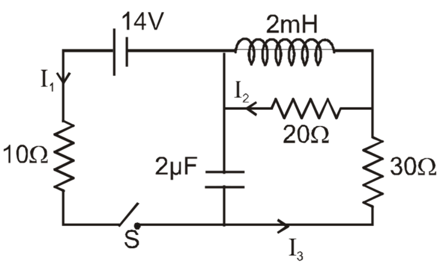
$$i = \frac{10}{10}\sin(50\pi t - 37)$$

$$V_{AB} = i \times R = 8\sin(50\pi t - 37)$$



Q-5 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In the circuit shown, the switch is closed at $t = 0$, the currents I_1, I_2 and I_3 are



(A) 1.4A,0,0

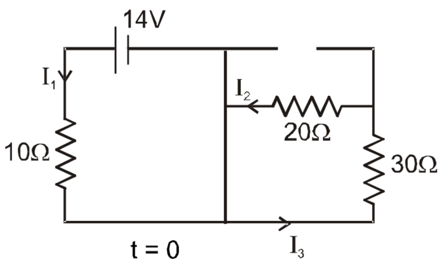
(B) 1.4 A,0.70 A,0.70 A

(C) 0,0,0

(D) 1.2A,0.6A,0.6A

Correct Option : A

SOLUTION



$$I_1 = \frac{14}{10} = 1.4$$
$$I_2 = I_3 = 0$$

Q-6 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

An LCR series circuit is in resonance with the frequency of applied ac generator. Select the incorrect statement:

(A) Power consumed decreases on increasing frequency

(B) Power consumed decreases on decreasing frequency

(C) Impedence of the circuit decreases on increasing frequency

(D) Impedence of the circuit increases on increasing frequency

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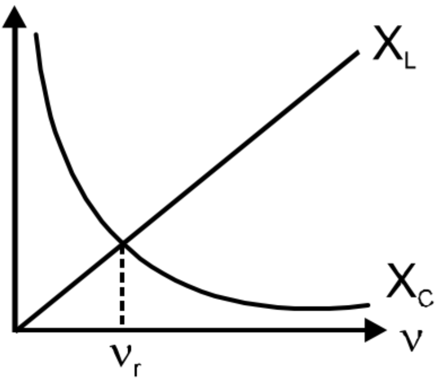
Correct Option : C

SOLUTION



From graph, when frequency is increased more then resonating frequency $(X_C \sim X_L)$ will increases hence impedence of the circuit will increases

Q-7 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

The series RLC circuit in resonance is called:

(A) selector circuit

(B) rejector circuit

(C) amplifier circuit

(D) oscillator circuit

Correct Option : A

SOLUTION

Only for resonating frequency circuit is able to drive appreciable current. So we can use these type of circuit in tunning of radio and TV for selecting perticular frequency sent by perticular source.

ATTEMPT FREE TEST ON DOUBTNUT

Q-8 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In a series LR circuit, the voltage drop across inductor is 8 volt and across resistor is 6 volt. Then voltage applied and power factor of circuit respectively are:

(A) 14V,0.8

(B) 10V,0.8

(C) 10 V,0.6

(D) 14 V,0.6

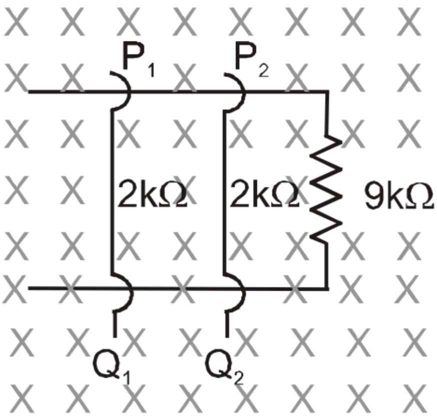
Correct Option : C

SOLUTION

$$V_L = 8V, V_R = 6V, V = \sqrt{\left(V_L^2 + V_R^2\right)} = 10V$$

$$\text{Power factor } = \cos\phi = \frac{V_R}{V} = \frac{6}{10} = 0.6$$

In the diagram shown, the wires P_1Q_1 and P_2Q_2 each of length $40cm$ are made to slide on the rails with same speed of $5m / s$. In this region a magnetic field of $1T$ exists. The electric current in $9k\Omega$ resistor is



(A) zero if both wires slide towards left.

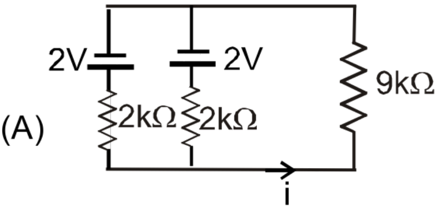
(B) 0.1 mA if both slide is opposite direction

(C) 0.2 mA if both wires move towards left.

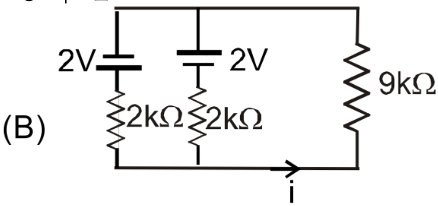
(D) 0.2 mA if both wires move in opposite direction

Correct Option : C

SOLUTION



$$i = \frac{2}{9+1} = 0.2A$$



(B)

$i = 0$

Q-10 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In a Young\'s double slit experiment, the separation between the slits is d, distance between the slit and screen is D(D>>d). In the interference pattern, there is a maxima exactly in front for each slit. Then the possible wavelength used in the experiment are:

(A) $\frac{d^2}{D}, \frac{d^2}{2D}, \frac{d^2}{3D}$

(B) $\frac{d^2}{D}, \frac{d^2}{3D}, \frac{d^2}{5D}$

(C) $\frac{d^2}{2D}, \frac{d^2}{4D}, \frac{d^2}{6D}$

(D) none of these

Correct Option : C

SOLUTION

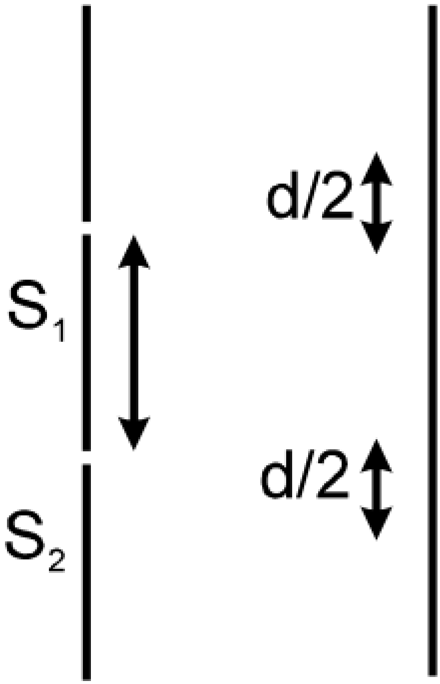
Fringe width $= n\frac{\lambda D}{d}$

From given situation

$$F.W. = \frac{d}{2}$$

$$\Rightarrow n\frac{\lambda D}{d} = \frac{d}{2} \Rightarrow \lambda = \frac{d^2}{2nD}$$

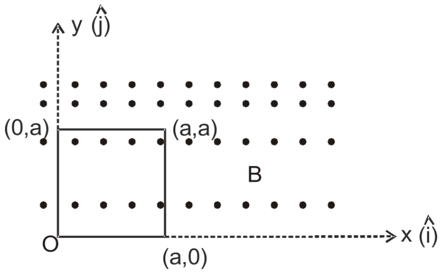
Hence (C) is possible .



Q-11 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A square loop of side \'a\' is placed in $x - y$ plane as shown in figure.

In this region there is non-uniform time dependent magnetic field $\overrightarrow{B} = (cy^3t^2)\overrightarrow{k}$, [where t is time and c is constant] then magnitude of emf induced in loop is



(A) Zero

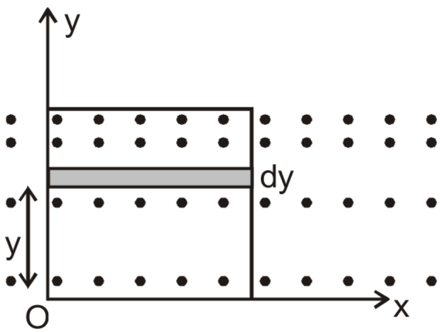
(B) $\dfrac{ca^4t^2}{5}$

(C) $\dfrac{ca^5t}{2}$

(D) data is insufficient

Correct Option : C

SOLUTION



$$\phi = \int \vec{B} . \vec{dA}$$

$$\phi = \int c y^3 t^2 a dy$$

$$\phi = ct^2 . A \int_0^a y^3 dy$$

$$\phi = ct^2 a . \frac{a^4}{4}$$

$$\phi = \frac{ct^2 a^5}{4}$$

$$e = \left| -\frac{d\varphi}{dt} \right|$$

Now induced e.m.f.

$$e = \left| -\frac{2cta^5}{4} \right| = \frac{2cta^5}{4} = \frac{cta^5}{2}$$

Q-12 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In a YDSE, distance between the slits and the screen is 1m, separation between the slits is 1mm and the wavelength of the light used is $5000 nm$. The distance of 100^{th} maxima from the central maxima is:

(A) 0.5 m

(B) 0.577 m

(C) 0.495 m

(D) does not exist

Correct Option : B

SOLUTION

For 100 the maximum

$$d\sin\theta = 100\lambda$$

$$\sin\theta = \frac{100 \times 5000 \times 10^{-9}}{1 \times 10^{-3}} = \frac{5 \times 10^{-4}}{10^{-3}} = 0.5 = \frac{1}{2}$$

$$\therefore y = D\tan\theta$$

$$= 1 \times \tan 30$$

$$= \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3} = \frac{1.732}{3} = 0.577$$

Q-13 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A rectangular loop of sides of length l and b is placed in x-y plane. A uniform but time varying magnetic field of strength $\vec{B} = 20t\hat{i} + 10t^2\hat{j} + 50\hat{k}$ where t is time elapsed. The magnitude of induced emf at time t is:

(A) 20+20t

(B) 20

(C) 20t

(D) zero

Correct Option : D

SOLUTION

The area vector of loop $\vec{A} = \pm\, lb\hat{k}$

& $\vec{B} = 10t\hat{i} + 10t^2\hat{j} + 50\hat{k}$

$\therefore$ Magnetic flux is $\phi = \vec{B}\,.\,\vec{A} = \pm\, 50lb$

$\therefore Emf = \dfrac{d\phi}{dt} = 0$

Q-14 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

Assume Earth\'s surface is a conductor with a uniform surface charge density σ. It rotates about its axis with angular velocity ω. Suppose the magnetic field due to Sun at Earth at some instant is a uniform field B pointing along earth\'s axis. Then the emf developed between the pole and equator of earth due to this field is. ($R_e =$ radius of earth)

(A) $\frac{1}{2}B\omega R_e^2$

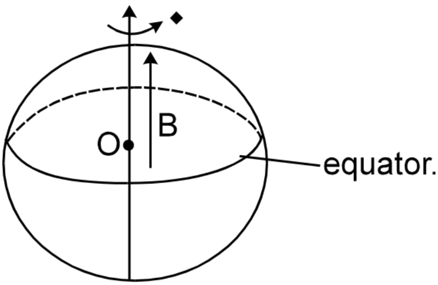
(B) $B\omega R_e^2$

(C) $\frac{3}{2}B\omega R_e^2$

(D) zero

Correct Option : A

SOLUTION



the equator can be seen as a conducting ring of raduis R_e revolving with angular velocity ω in perpendicular magnetic field B.

$\therefore$ Potential difference across its centre and periphery $= \dfrac{B\omega R_e^2}{2}$

Potential at pole =potential of the axis of earth i.e. potential at point O

$$\therefore V_{\text{equator}} - V_{\text{Pole}} = \frac{B\omega R_e^2}{2}$$

Q-15 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A series RLC circuit is connected to an ac generator. The instant at which current in the circuit is zero, the energy stored in the capacitor and inductor are:

(A) zero in both

(B) maximum in both

(C) zero & maximum respectively

(D) maximum & zero respectively

Correct Option : D

SOLUTION

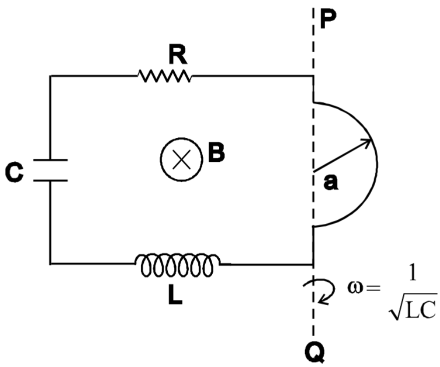
$$\frac{dq}{dt} = i = 0Q \rightarrow \ \text{max}$$

$$E_c = \frac{Q^2}{2c} \Rightarrow \ \text{max}$$

$$E_L = \frac{Li^2}{2} \Rightarrow zero$$

Q-16 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A wire shaped as a semicircle of radius a, is rotating about an acis PQ with a constant angular velocity $\omega = \frac{1}{\sqrt{LC}}$, with the help of an external agent. A uniform magnetic field B exists in space and is directed into the plane of the figure. (circuit part remains at rest) (left part is at rest)



(A) The rms value of current in the circuit is $\frac{\pi B a^2}{R\sqrt{2LC}}$

(B) The rms value of current in the circuit is $\frac{\pi B a^2}{2R\sqrt{2LC}}$

(C) The maximum energy stored in the capacitor is $\frac{\pi^2 B^2 a^4}{8R^2 C}$

(D) The maximum power delivered by the external agent is $\frac{\pi^2 B^2 a^4}{4LCR}$

Correct Option : BCD

SOLUTION

Let at time t the angle between magnetic field and area vector

(semicircle) be θ, then $\theta = wt$

$$\phi = \vec{B} . \vec{S} = \frac{\pi a^2 B}{2} \cos \omega t.$$

$$\varepsilon = -\frac{d\phi}{dt} = \frac{\pi B a^2 \omega}{2} \sin \omega t$$

$$\varepsilon_0 = \frac{\pi B a^2}{2\sqrt{LC}} \text{ peak emf}$$

Since the circuit is in resonance

$$|z| = R \Rightarrow i_0 = \frac{\pi B a^2}{2R\sqrt{LC}} \text{ peak current}$$

$$i_{rms} = \frac{i_0}{\sqrt{2}} \Rightarrow i_{rms} = \frac{\pi B a^2}{2R\sqrt{2LC}}$$

$$U_C = \frac{1}{2} C V_0^2 \rightarrow \text{max. energy } V_0 \rightarrow \text{ peak voltage}$$

$$V_0 = i_0 X_c = \frac{i_0}{C\omega} = \frac{i_0\sqrt{LC}}{C}$$

$$U_C = \frac{1}{2} C \times \frac{\pi^2 B^2 a^4}{4R^2C^2} = \frac{\pi^2 B^2 a^4}{8R^2C}$$

$$P_{ext.} = P_{\text{Dissipated}} = \varepsilon_0 i_0 = \frac{\pi B a^2}{2\sqrt{LC}} \times \frac{\pi B a^2}{2R\sqrt{LC}}, P_{Ext} = \frac{\pi^2 B^2 a^4}{4LCR}$$

Q-17 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

Consider a series LCR circuit connected to an AC supply of 220V. If voltage drop across resistance R is $V_R,$ voltage drop across capacitor is $V_c = 2V_R$ and that across inudctor coil is $V_L = 2V_R$ then choose correct alternative(s)

(A) $V_R = 220\sqrt{2}$

(B) Power factor of circuit is $\frac{1}{\sqrt{2}}$

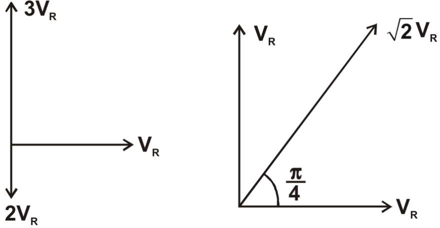
(C) $V_R = 156V$

(D) Phase difference between current and source voltage is $\frac{\pi}{4}$

Correct Option : BCD

SOLUTION

V_R, V_L, V_C are rms voltage across the R,L & C respectively



$$\theta = \frac{\pi}{4}$$

$$P.F. = 1000 = \frac{1}{\sqrt{2}}$$

$$\sqrt{2}V_R = 220$$

$$V_R = \frac{220}{\sqrt{2}} = 156V$$

Q-18 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

If the two slits of double slit experiment were moved symmetrically apart with small relative velocity v and the distance between screen and mid-point of slits is fixed and equal to D. Consider a point P on the screen at a distance x from central maxima then (x<<

(A) Rate of change of number of fringes between central maxima and point P changes with respect to time is $\frac{xv}{\lambda D}$

(B) number of fringes contained between central maxima and point P increases with time

(C) fringe width decreases as time passes

(D) fringe width increases as time passes

Correct Option : ABC

SOLUTION

Let N be the number of fringes within the length x, then we have,

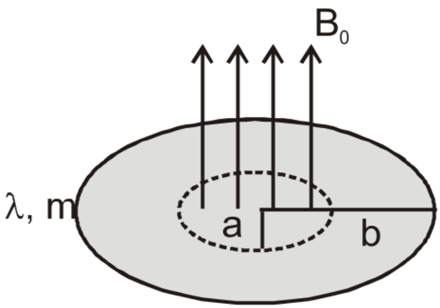
$$\beta N = x \Rightarrow \frac{D\lambda}{d} N = x \Rightarrow N = \frac{xd}{\lambda D}$$

At any time t

$$N = \frac{x}{\lambda D}(d + vt)$$
$$\frac{dN}{dt} = \frac{xv}{\lambda D}$$

Q-19 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A nonconducting ring of uniform mass m, radius b and uniform linear charge density λ is suspended as shown in figure in a gravity free space. There is uniform coaxial magnetic field B_0, pointing up in a circular region of radius \'a\' $(< b)$. Now if this field is switched off, then:-



(A) There will be induced electric field on periphery of ring, in anticlockwise sense when seen from above

(B) Induced electric field imparts angular momentum of magnitude $\lambda\pi a^2 b B_o$

(C) Final angular velocity of ring will be more if time taken to switch of the field B_o is small

(D) Final angular velocity will always be independent of time taken to switch off the field B_o

---

Correct Option : ABD

SOLUTION

Changing magnetic field (at switching off B_0 to zero) induced electric field in such a way to restore the upwards flux, hence anticlockwise (E) as seen from above

$$\int \vec{E} \cdot \vec{dl} = -\frac{d\phi}{dt} = -\pi a^2 \frac{dB}{dt} = \int E dl$$

There is force on small element dQ of ring, tangentially Now this force produces torque about axis of ring to rotate in anticlockwise sense, so

$$\tau = \int dQE \times b = \int \lambda dl E b = \lambda b \int E dl = \lambda b \pi a^2 \frac{dB}{dt}$$

So impulse or torque

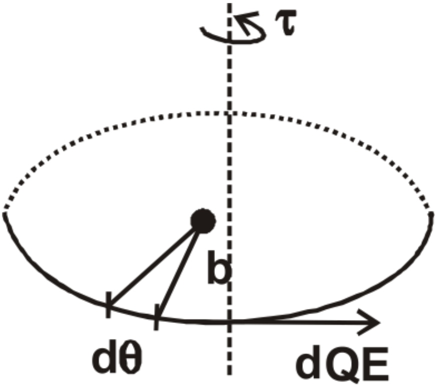
$$\int \tau dt = \lambda b \pi a^2 \int_{B_0}^{2} dB = \int \tau dt = \lambda b \pi a^2 B_0$$

$$L_f - L_i = \Delta L = \int \tau dt = \lambda b \pi a^2 B_0 = I\omega \text{ (in magnitude)}$$

It is indpendent of time taken $I\omega_f - I\omega_i = \lambda b \pi a^2 B_0$

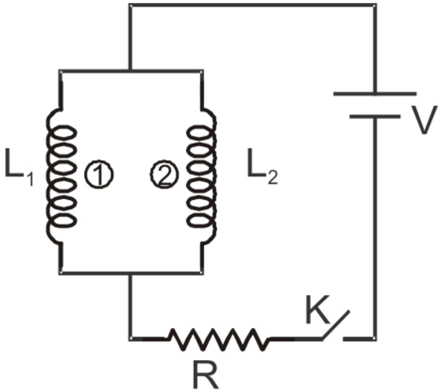
where I is moment of inertia

So, $\omega_f = \dfrac{\lambda b \pi a^2 B_0}{mR^2}$



Q-20 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In the figure shown the key is switched on at $t = 0$. Let l_1 and l_2 be the currents through inductors having self inductances L_1 and L_2 at any time t respectively. The magnetic energy stored in the inductors 1 and 2 be U_1 and U_2. Then $\frac{U_1}{U_2}$ at any instant of time is:



(A) $\frac{L_1}{L_2}$

(B) $\frac{L_2}{L_1}$

(C) $\frac{I_1}{I_2}$

(D) $\frac{I_2}{I_1}$

Correct Option : BC

SOLUTION

Because both inductors are in parallel

$\therefore L_1 I_1 = L_2 I_2$

$$\frac{U_1}{U_2} = \frac{1/2 L_1 I_1 I_1}{1/2 L_2 I_2 I_2} = \frac{I_1}{I_2} = \frac{L_2}{L_1}$$

Q-21 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In a Young\'s double slit experiment, films of thickness t_A and t_B and refcative indices μ_A and μ_B are placed in front of slits A and B respectively. If $\mu_A t_A = \mu_B t_B$, then the central maxima may

(A) not shift

(B) shift towards A

(C) shift towards B

(D) none of these

Correct Option : ABC

SOLUTION

The path difference

$\Delta x = (\mu_A - 1)t_A - (\mu_B - 1)t_B$

$\Rightarrow \Delta x = \mu_A t_A - t_A - \mu_B t_B + t_B$

$\Rightarrow \Delta x = t_B - t_A$

if $t_B = t_A \Rightarrow \Delta x = 0$

$\Rightarrow$ no shift

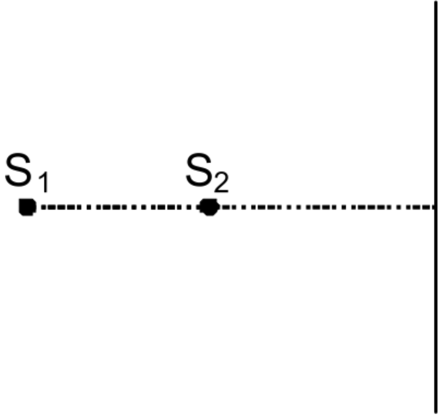
if $t_B > t_B$ or $t_B < t_A$

$\Delta x \neq \; = 0$

$\Rightarrow$ central maxima may shift towards A or B

Q-22 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

Two coherent monochromatic point sources S_1 and S_2 are placed in front of an infinite screen as shown in figure. Wavelength of the light emitted by both the sources is zero. Initial phase difference between the sources is zero.



Initially $S_1S_2 = 2.5\lambda$ and the number of bright circular rings on the screen in n_1. if the distance S_1S_2 is increased and made 5.7λ, the number of bright circular rings becomes n_2. the difference $n_2 - n_1$ is

(A) 1

(B) 2

(C) 3

(D) 4

Correct Option : C

SOLUTION

For $S_1S_2 = 2.5\lambda$, max path difference $= 2.5\lambda$

min path difference =0

Between 2.5λ and 0 lie 2λ and $\lambda \Rightarrow$ two circular bright fringes

$n_1 = 2$

For $S_1S_2 = 5.7\lambda$, max path difference =5.7λ

min path difference =0

Between 5.7λ and 0 lie 5λ, 4λ, 2λ, $\lambda \Rightarrow$ five circular bright fringes.

$\Rightarrow n_2 = 5$

$\therefore n_2 - n_1 = 5 - 2 = 3$

Q-23 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

A conducting circular loop having a radius of 1.0 cm, is placed perpendicular to a magnetic field of 0.50 T .It is removed from the field in 0.50 s. The average emf produced in the loop during this time is $x\pi \times 10^{-4} V$ .then find out value of x

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

(B) 1

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

(D) 2

Correct Option : B

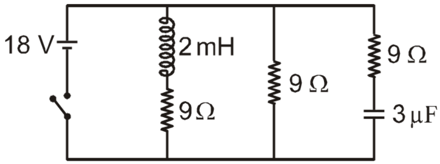
SOLUTION

$$\varepsilon = -\frac{\Delta\phi}{\Delta t} = -\frac{(\phi_1 - \phi_2)}{\Delta t}$$
$$= \frac{\phi_1 - \phi_2}{\Delta t}$$
$$= \frac{BA - 0}{\Delta t} = \frac{0.5 \times \pi(1 \times 10^{-2})^2}{0.5} = \pi \times 10^{-4} V$$

Q-24 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In circuit,initially capacitor and inductor do not have any energy,

Then find current through the battery in Ampere just after switch is closed



(A) 1

(B) 2

(C) 3

(D) 4

Correct Option : D

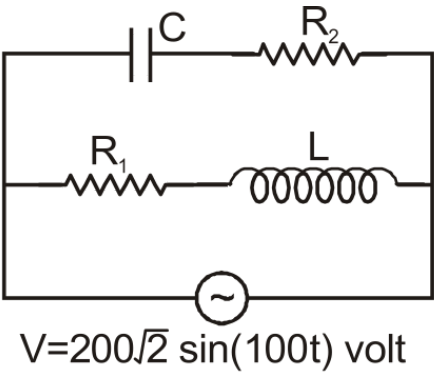
SOLUTION

Just after the switch is closed, there is no current through the coil and capacitor offers no resistance. Net resistance

$$= \frac{9}{2} = 4.5\Omega \Rightarrow i_0 = \frac{18}{4.5} = 4A$$

Q-25 - JEE ADVANCED-PART TEST-13 (PHYSICS)-PHYSICS

In the shown circuit, $R_1 = 10\Omega$, $L = \frac{\sqrt{3}}{10}H$, $R_2 = 20\Omega$, $C = \frac{\sqrt{3}}{2}$ milli-farad and t is in time in seconds. Then at the instant current through R_1 is $10\sqrt{2}A$, find the current through resistor R_2 in amperes.



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

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

(C) 0

(D) 2

Correct Option : C

SOLUTION

For R_1-L branch

$$X_L = \omega L = 100 \times \frac{\sqrt{3}}{10} = 10\sqrt{3}\Omega, R_1 = 10\Omega$$

$$\therefore \tan\phi = \frac{X_L}{R_1} = \sqrt{3} \text{ or } \phi = 60$$

Hence current I_1 lags voltage by 60 For $R_2 - C$ branch

$$X_C = \frac{1}{\omega C} = \frac{1}{100 \times \frac{\sqrt{3}}{2} \times 10^{-3}} = \frac{20}{\sqrt{3}}\Omega$$

$$\therefore \tan\phi = \frac{X_C}{R_2} = \frac{1}{\sqrt{3}} \text{ or } \phi = 30$$

Hence current I_2 leads voltage by 30

$\therefore$ The phase difference between I_1 and I_2 branch is 90

The maximum current through $R_1 - L$ branch is

$$= \frac{V_0}{\sqrt{R_1^2 + \omega^2 L^2}} = \frac{200\sqrt{2}}{\sqrt{10^2 + \left(10\sqrt{3}\right)^2}} = 10\sqrt{2}amp.$$

Hence when current through $R_1 - L$ branch is $10\sqrt{2}$ amp. the current through $R_2 - C$ branch will be zero.