Exam: JEE Main
Date: 8th April 2019 – Morning Session (Shift 1)
Subject: Physics

#1611026
Topic: Capacitance

A capacitor of capacitance $C = 15pF$ is charged with voltage $V = 500V$. The electric field inside the capacitor with dielectric is $10^6 V/m$ and the area of the plate is $10^{-4}m^2$ then the dielectric constant of the medium is :($\varepsilon 0 = 8.85 \times 10^{-12}$ in S.I.units)

A 12.47

B 8.47

C 10.85

D 14.85

Solution

$$E = \frac{V}{d} = \frac{VC}{AK\varepsilon_0}$$

$$K = \frac{VC}{A\varepsilon_0 E} = \frac{500 \times 15 \times 10^{-12}}{10^{-4} \times 10^6 \times 8.85 \times 10^{-12}} = 8.47$$

#1611028
Topic: Electric Field

The electric field of EM wave is $6volt/m$. The magnetic field associated with the wave if the wave is propagating in $+x$ direction and electric field along y-axis is ?

A $10^{-8}T\hat{k}$

B $2 \times 10^{-8}T\hat{k}$

C $3 \times 10^{-8}T\hat{k}$

D $4 \times 10^{-8}T\hat{k}$

Solution

$$E = BC$$

$$B = \frac{E}{C} = \frac{6}{3 \times 10^8} = 2 \times 10^{-8}T\hat{k}$$

#1611030
Topic: Atomic Spectra and Spectral Series

An electron of H-atom de-excites from energy level $n_1 = 2$ to $n_2 = 1$ and the emitted photon is incident on He^+ ions in ground and first excited state. Which of following transition is possible.

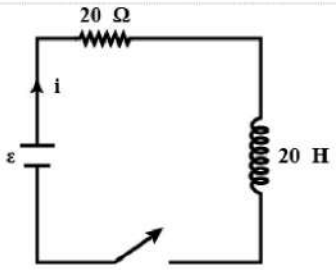
A $n = 1$ to $n = 4$

B $n = 2$ to $n = 4$

C $n = 2$ to $n = 3$

D $n = 1$ to $n = 3$

#1611033
Topic: Purely inductive circuit



The switch is closed at $t = 0$. The time after which the rate of dissipation of energy in the resistor is equal to rate at which energy is being stored in the inductor is :

A $\ell n2$

B $\frac{1}{2}\ell n2$

C $\frac{1}{4}\ell n2$

D $2\ell n2$

Solution

$i = \frac{E}{R}(1 - e^{-\frac{Rt}{L}})$

$\frac{di}{dt} = \frac{E}{L}e^{-\frac{t}{\tau}}$ where $\tau = \frac{L}{R}$

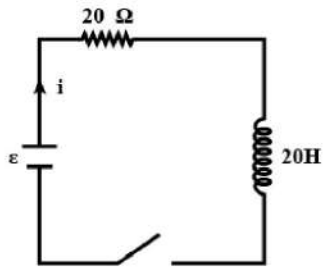
$i^2R = i(L\frac{di}{dt})$

$\frac{E}{R}R(1 - e^{-\frac{t}{\tau}}) = L\frac{E}{L}e^{-\frac{t}{\tau}}$

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

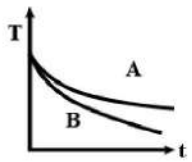
$\ell n2 = \frac{t}{\tau}$

$t = \tau\ell n2 = \ell n2$



#1611035
Topic: Radiation

Two identical containers of same emissivity containing liquids A & B at same temperature of 60^0C initially and density ρA and ρB respectively, Where $\rho A < \rho B$. Which plot best represents the temperature variation of both with time? Given $(S_A = 1000\frac{J}{kg-K}, S_B = 2000\frac{J}{kg-K})$

A


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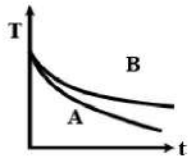

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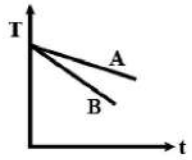

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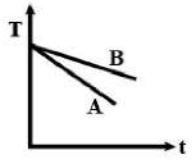
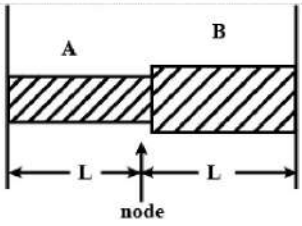


#1611038
Topic: Standing Waves



The system of two rods shown in figure is vibrating at the same frequency and forming a standing wave. The ratio of the number of antinodes in the two rods if radius of rod B twice the radius of A is :

A 1

B 2

C 3

D 4

Solution

$f_1 = \frac{n}{2\ell}\sqrt{\frac{T}{\rho A}}\ f_2 = \frac{m}{2\ell}\sqrt{\frac{T}{\rho 4A}}$

Given $f_1 = f_2$

$\frac{f_1}{f_2} = \frac{n}{m} \times 2$

$\frac{n}{m} = 2$

#1611180
Topic: Modulation

The wavelength of carrier wave in optical cable fiber is:

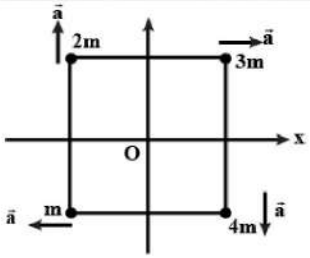
A $900nm$

B $2700nm$

C $1500nm$

D $2000nm$

#1611197
Topic: Centre of mass



At a given instant, four particle having masses and acceleration as shown in the figure lie at vertices of a square. Acceleration of the center of mass of the system is:

A $\frac{1}{5}(\hat{i}+\hat{j})$

B $\frac{1}{5}(\hat{j}-\hat{i})$

C $\frac{1}{5}(\hat{i}-\hat{j})$

D $-\frac{1}{5}(\hat{i}+\hat{j})$

Solution

$\therefore \vec{a}_{cm} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2 + \ldots\ldots}{m_1 + m_2 + \ldots\ldots}$

$= m \times (-a\hat{i}) + 2m(a\hat{j}) + 3m(a\hat{i}) + 4m + (-a\hat{j})m + 2m + 3m + 4m$

$= \frac{2\hat{i}-2\hat{j}}{10} = \frac{1}{5}(\hat{i}-\hat{j})$

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#1611201
Topic: Interference

In YDSE ratio of amplitude of waves is $1:3$. The ratio of $I_{max}:I_{min}$ is:

A $1:4$

B $4:1$

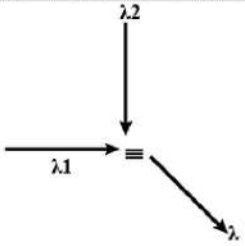
C $1:1$

D $1:9$

Solution

$$\frac{I_{max}}{I_{min}}=\frac{[\sqrt{I_1}+\sqrt{I_2}]^2}{(\sqrt{I_1}-\sqrt{I_2}^2}=(\frac{A_1+3A}{A_1-3A_1})^2$$
$$=(\frac{4}{2})^2=\frac{4}{1}$$

#1611205
Topic: Dual Nature



Two particle are moving perpendicular to each other with de-Broglie wave length λ_1 and λ_2. If they collide and stick together, then the de-Broglie wave length of system after collision is:

A $\lambda=\frac{\lambda_1\lambda_2}{\sqrt{\lambda_1^2+\lambda_2^2}}$

B $\lambda=\frac{\lambda_1}{\sqrt{\lambda_1^2+\lambda_2^2}}$

C $\lambda=\frac{\sqrt{\lambda_1^2+\lambda_2^2}}{\lambda_2}$

D $\lambda=\frac{\lambda_1\lambda_2}{\sqrt{\lambda_1+\lambda_2}}$

#1611211
Topic: Relative Motion

Ship A is moving with velocity $\vec{V}_1=30\hat{i}+50\hat{j}$ from position $(0,0)$ and ship B is moving with velocity $\vec{V}_2=-10\hat{i}$ from position $(80,150)$. The time for minimum separation between the two ships is:

A 2.6

B 2.2

C 2.4

D None

Solution

$$\vec{V}_r=40\hat{i}+50\hat{j}$$
$$\vec{r}_r=-80\hat{i}-150\hat{j}$$
$$t_{min}=\frac{\left|\vec{V_r}.\vec{r_r}\right|}{\vec{V}|^2}\frac{10700}{4100}=\frac{107}{41}=2.6sec$$

#1611215
Topic: Elastic and Plastic Substances

10^{22} particle each of mass $10^{-26}Kg$ are striking perpendicularly on a wall of area $1m^2$ with speed $10^4m/s$ in $1sec$. The pressure on the wall if collisions are perfectly elastic i

A $2N/m^2$

B $4N/m^2$

C $6N/m^2$

D $8N/m^2$

Solution

$v = 10^4 m/s$

$m = 10^{-26}$

$n = 10^{22}$

$A = 1m^2$

$\Delta p = 2mnv$

$\Delta p = 2 \times 10^{22} \times 10^{-26} \times 10^4 = 2$

$P = \frac{F}{A} = 2N/m^2$

#1611217
Topic: Resistance and Resistivity

A carbon resistance with color band is 200Ω. If red band is replaced by green band then the new resistance is:

A 500Ω

B 300Ω

C 400Ω

D 100Ω

#1611221
Topic: Identification of Units

Dimension of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ are

A $[ML^2T^{-3}A^{-2}]$

B $[M^{-1}L^{-2}T^3A^2]$

C $[M^2L^2T^{-3}A^{-2}]$

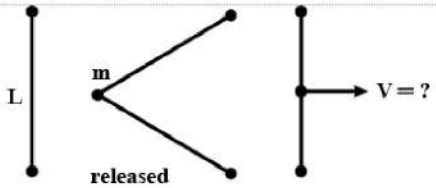
D $[M^{-1}L^2T^3A^2]$

Solution

$\sqrt{\frac{\varepsilon_0}{\mu_0}} = \sqrt{\frac{\varepsilon_0^2}{\mu_0\varepsilon_0}} = \varepsilon_0 c = [M^{-1}L^{-3}T^4A^2][LT^{-1}]$

$[M^{-1}L^{-2}T^3A^2]$

#1611238
Topic: Young's Modulus



An elastic string of length $42sm$ and cross-sectional area $10^{-4}m^2$ is attached between two pegs ar distance of $6mm$ as shown in the figure. A particle of mass m is kept at midpoint of string and stretched as shown in figure by $20cm$ and release. As the string its natural length, the particle attains a speed of $20m/s$. Then young modulus Y of strir is of order

A 10^8

B 10^{12}

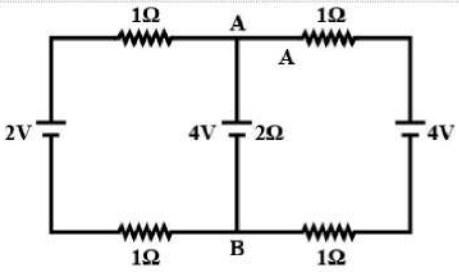
C 10^{6}

D 10^{4}

Solution

$$\frac{1}{2}\times Y\times(\frac{\Delta l}{L})^2=\frac{1}{2}mv^2Y\times\frac{(0.2)^2}{0.42}\times10^4=0.05\times400=\frac{1}{2}mv^2Y=\frac{0.05\times400\times0.42}{(0.2)^2\times10^4}=2.1\times10^6N/m^2$$

#1611254
Topic: Resistance and Resistivity



The potential difference between the points A and B for the electric circuit shown in figure. is:

A $\frac{10}{3}$

B $\frac{20}{3}$

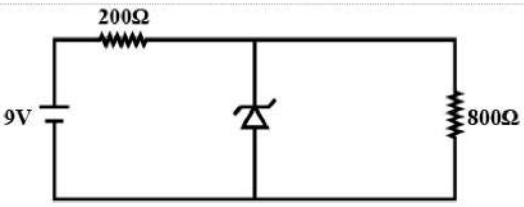
C $\frac{5}{3}$

D $\frac{7}{3}$

Solution

Applying parallel combination of the batteries $E_{equ}=\frac{\frac{E_1}{r_2}+\frac{E_2}{r_2}+----}{\frac{1}{r_1}+\frac{1}{r_2}+----}=\frac{\frac{2}{2}+\frac{4}{2}+\frac{4}{2}}{\frac{1}{2}+\frac{1}{2}+\frac{1}{2}}\Rightarrow E_{equ}=\frac{10}{2-\frac{3}{2}}=\frac{10}{3}V$

#1611265
Topic: Zener Diode



Determine the current through zener diode for the circuit shown in figure is: (Given: zener diode break down voltage $V_z=5.6V$)

A $7mA$

B $17mA$

C $10mA$

D $15mA$

Solution

For zener brak down potential difference across 800Ω resistor will be $5.6V$4

$V_z = 5.6V$

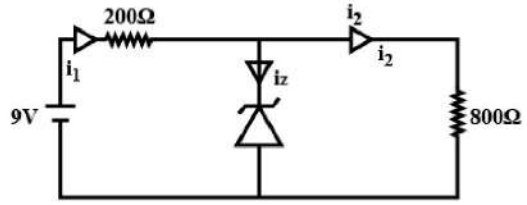
$i_2 = \frac{V_z}{800} = \frac{5.6}{800} = 7mA$

ΔV across $200\Omega = 9 - 5.6 = 3.4V$

$i_1 = \frac{3.4}{200} = 17mA$

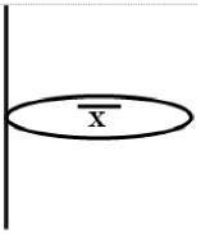
$i_1 = 1_2 + i_z$

$i_z = 17mA - 7mA = 10mA$



#1611293

Topic: Moment of Inertia of Common Bodies



The density of a circular disc is given as $\sigma = \rho o X$ where 'x' is the distance from the centre. Its moment of inertia about an axis perpendicular to its plane and passing through i edge is:

A $\frac{15}{16}\rho o^{\pi R^5}$

B $\frac{16}{15}\rho o^{\pi R^5}$

C $\frac{6}{5}\rho o^{\pi R^5}$

D $\frac{5}{6}\rho o^{\pi R^5}$

Solution

$dt = dmx^2 + dmR^2$

Now, $dm = \sigma 2\pi x\, dx$

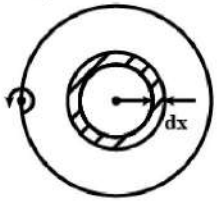
$dm = \rho o x 2\pi x\, dx$

$= \rho o 2\pi x^2\, dx$

$\int dI = \int_0^R \rho o 2 \quad \pi x^4 dx + \int_0^R \rho o 2\pi R^2 x^2 dx$

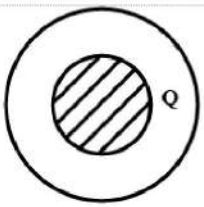
$I = \frac{\rho o 2\pi R^5}{5} + \frac{\rho o 2\pi R^5}{3}$

$\frac{8\rho o 2\pi R^5}{15} = \frac{16\rho o \pi R^5}{15}$



#1611324

Topic: Electric Charge



A conducting sphere is enclosed by a hollow conducting shell. Initially the inner sphere has a charge Q while the outer one is uncharged . The potential difference between th two spherical surface is found to be V. Later on the outer shell is given a charge $-4Q$. The new potential difference between the two surface is:

A V

B $-V$

C $-2V$

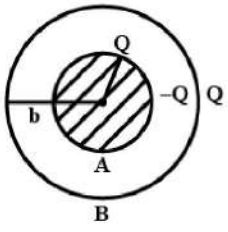
D $2V$

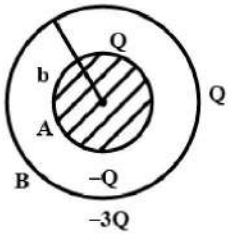
Solution

$$V_A = \frac{KQ}{a} + \frac{K(-Q+Q}{b}$$
$$V_B = \frac{KQ}{b} + \frac{K(-Q+Q}{b}$$
$$\Delta V_i = V_A - V_B = KQ\left(\frac{1}{a} - \frac{1}{b}\right) = V$$

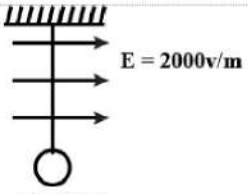
Finally

$$V_A = \frac{KQ}{a} - \frac{K4Q}{b}$$
$$V_B = \frac{KQ}{b} - \frac{K4Q}{b}$$
$$\Delta V_i = V_A - V_B - KQ\left(\frac{1}{a} - \frac{1}{b}\right) = V$$





#1611334
Topic: Electric Field



A small sphere of mass $m = 2gm$ having charge $Q = 5\mu C$ is suspended using an insulated string as shown in figure. The angle θ made by the sphere with vertical if it is placed in an electric field of magnitude $2000v/m$ towards right is:

A $tan^{-1}(5)$

B $tan^{-1}(0.5)$

C $tan^{-1}(2)$

D $tan^{-1}(0.2)$

Solution

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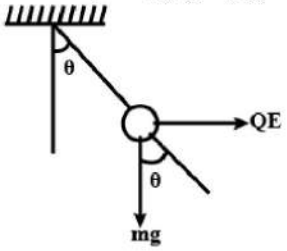
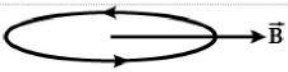
$$\tan\theta = \frac{QE}{mg} = \frac{5\times10^{-6}\times2000}{2\times10^{-3}\times10} = \frac{1}{2}$$



#1611344
Topic: Magnetic field



A circular loop of radius r having N number of turns carrying current I is placed in a uniform magnetic field $\vec{B}$ parallel to the plane of the loop. The torque on the loop is:

A $NI\pi r^2 B$

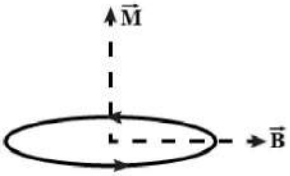
B $N^2 I\pi r^2 B$

C $NI^2\pi r^2 B$

D $NI\pi r^2 B^2$

Solution

$|\vec{M}| = NI\pi r^2 \vec{\tau} = \vec{M}\times\vec{B}|\vec{\tau}| = MB\sin\theta = NI\pi r^2 \sin 90^o \times B|\vec{\tau}| = NI\pi r^2 B$



#1611345
Topic: Basics of AC

An A.C source of voltage $V = 220sin(100\pi t)$ volts is connected with resistance $R = 50\Omega$. The time interval in which the current goes from its peak value to half of the peak value is:

A $\frac{1}{400}sec$

B $\frac{1}{50}sec$

C $\frac{1}{300}sec$

D $\frac{1}{200}sec$

Solution

$I = \frac{200}{50}\sin(100\pi l)$
$T = \frac{2\pi}{100\pi} = \frac{1}{50}\text{sec}$
$\Delta T = \frac{T}{6} = \frac{1}{50\times6} = \frac{1}{300}sec$

#1611346
Topic: Graphs in Kinematics

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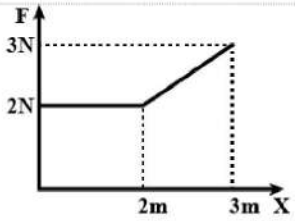


Force versus displacement graph of a particle starting from rest is given in the figure shown. The kinetic energy of particle at $x = 3m$ is:

A $6.5J$

B $7.5J$

C $6J$

D $5J$

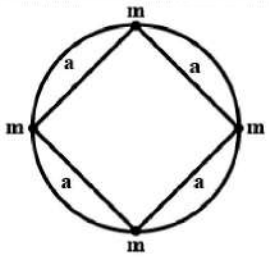
Solution

$W = k_f - K_f$

$W = 2 \times 2 + \frac{1}{2} \times (2+3) \times 1 = kr$

$= 4 + 2.5 = 6.5J$

#1611347
Topic: Gravitational Potential



Four particle each of mass m are undergoing circular motion under the influence of action of their mutual gravitational interaction while being at the vertices of a square of side a. Their speeds are

A $\sqrt{\frac{2Gm}{a}}$

B $1.16\sqrt{\frac{Gm}{a}}$

C $1.5\sqrt{\frac{Gm}{a}}$

D $\sqrt{\frac{Gm}{a}}$

Solution

$r = \frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}}$

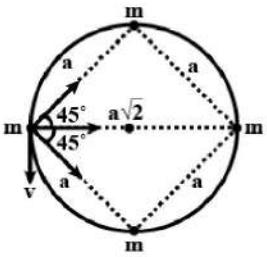
$\frac{Gmm}{a^2}\frac{1}{\sqrt{2}} + \frac{Gmm}{(a\sqrt{2}} + \frac{Gmm}{a^2}\frac{1}{\sqrt{2}} = \frac{mv^2}{a}\sqrt{2}$

$\frac{Gm^2}{a^2}\left(\frac{1}{\sqrt{2}} + \frac{1}{1} + \frac{1}{\sqrt{2}}\right) = \frac{mv^2}{a}\sqrt{2}$

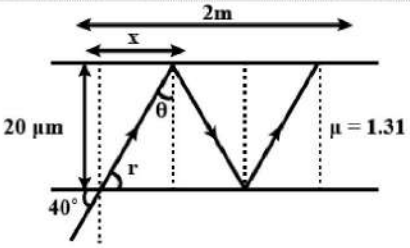
$\frac{Gm}{a}\left(\frac{1}{2} + \sqrt{2}\right) = \sqrt{2}.v^2$

$\sqrt{\frac{Gm}{a}\frac{(1+1\sqrt{2})}{2\sqrt{2}}} = v$

$v = 1.16\sqrt{\frac{Gm}{a}}$



#1611351
Topic: Reflection at Plane Surface



Find out no. of reflection after which light ray will exit from (Given sin $40^0 = 0.64$)

A 130000

B 57735

C 140000

D 150000

Solution

1 sin $40^0 = 1.31 sinr$

$0.64 = 1.31 sinr$

$sinr = \frac{0.64}{1.31} = 0.49 \approx 0.5$

$r = 30$

So $\theta = C$

$\because \theta > C$

$\therefore$ T.I.R. at other surface

$tanr = \frac{20\mu m}{x}$

$x = 20\sqrt{3}$

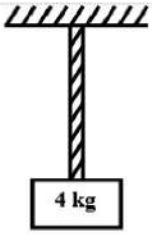
$n = \frac{2m}{20\sqrt{3}\mu m}$

$n = \frac{10^5}{\sqrt{3}}$

$n = 57735$

#1611353
Topic: Stress and Strain

Exam: JEE Main
Date: 8th April 2019 – Morning Session (Shift 1)
Subject: Physics



A block of mass $4kg$ is suspended from the ceiling with the help of a steel wire of radius $2mm$ and negligible mass. Find the stress in the wire.$(g = \pi^2)$

A $4.0 \times 10^6 N/m^2$

B $3.14 \times 10^6 N/m^3$

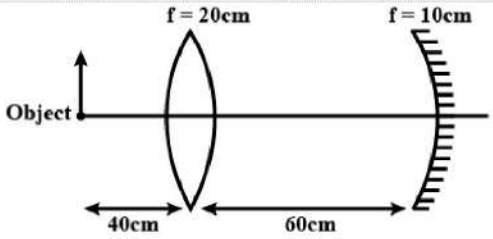
C $3 \times 10^5 N/m^3$

D $2.0 \times 10^6 N/m^2$

Solution

Stress=$\frac{F}{A} = \frac{mg}{A} = \frac{4 \times \pi^2}{\pi r^2} = \frac{4\pi}{r^2} = \frac{4 \times 3.1}{4 \times 10^{-6}}$
$= 3.14 \times 10^6 N/m^2$

#1611354
Topic: Thin Lenses



A converging lens of focal length $20cm$ is placed between an object & a concave mirror of focal length $10cm$ as shown in figure. The final image is:

A Coinciding with object enlarged, inverted, real

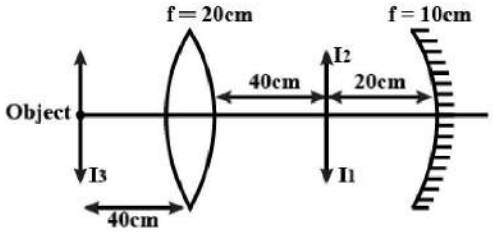
B Coinciding with object same size, erect, real

C Coinciding with object same size , inverted, virtual

D Coinciding with object same size, inverted ,real

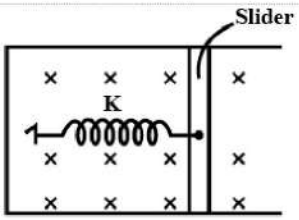
Solution

Image is same size, inverted, real and coinciding with object.



#1611360
Topic: Faraday's and Lenz's Law

Exam: JEE Main
Date: 8th April 2019 – Morning Session (Shift 1)
Subject: Physics



A conducting slider of resistance $R(10\Omega)$, mass $50g$ & $length 10cm$ is kept on a U-shaped frame as shown in figure. There is uniform magnetic field $(B = 0.1T)$ perpendicul to plane of frame. The slider is attached to a spring $(K = 0.5N/m)$. The slider is displaced by an amount A_0 & released. Time in which its amplitude become A_0/e is

A $9000s$

B $10000s$

C $12000s$

D $15000s$

Solution

$$-kx - \frac{i}{B} = m\frac{d^2x}{dt^2}$$
$$-kx - \frac{B^2l^2}{R}\frac{dx}{dt} - m\frac{d^2x}{dt^2} = 0$$
Comparing with
$$-Kx - b\frac{dx}{dt} - m\frac{d^2x}{dt^2} = 0$$
$$\frac{B^2l^2}{R.2m}t = 1$$
$$t = \frac{2mR}{B^2l^2} = 10,000s$$

#1611377
Topic: Viscosity

A liquid of coefficient of viscosity $\eta = 1$ poise is flowing in a pipe of radius $3cm$ such that the rate of volume flow is $1000\ell/min$. Determine the Reynolds numbers.

A 3563

B 3500

C 3400

D 3600

Solution

Rate of volume flow $= \pi r^2 = 100l/min$
$$\pi r^2 = \frac{1}{60}m^3/s$$
Reynolds number $= R_e = \frac{\rho vD}{\nu} = \frac{1000}{0.1} \times \frac{1}{60\pi r^2} \times 2r$
$$\frac{2000}{1.0 \times 60\pi \times 3 \times 10^{-2}} = 3563$$