JEE-Main-28-06-2022-Shift-1 (Memory Based)

Physics

Question: A man of mass 60 kg comes with velocity v and jumps into a car of mass 120 kg at rest the combined velocity is $2\,ms^{-1}$ then v is

Options:

(a) 2 m/s

(b) 6 m/s

(c) 8 m/s

(d) 10 m/s

Answer: (b)

Solution:

$m_{man} = 60kg = m_1$

$v_{man} = v$

$m_{car} = 120kg = m_2$

$v_{car} = 0 = u_2$

$v_{combined} = 2m/s = v$

So by linear momenum conservation

$m_1 v + m_2 \times 0 = (m_1 + m_2) v_{combined}$

$60 \times v = (60 + 120) \times 2$

$60v = 360$

$v = 6m/s$

Question: Two waves having wavelength 4.08, 4.16 produce 40 beats in 12 s find velocity in the medium

Options:

(a) 70 m/s

(b) 50 m/s

(c) 707 m/s

(d) 305 m/s

Answer: (c)

Solution: $v_1 - v_2 = \text{Beat frequency}$

$$\frac{v}{\lambda_1} - \frac{v}{\lambda_2} = \left(\frac{40}{12}\right)$$

$$v\left(\frac{1}{4.08} - \frac{1}{4.16}\right) = \left(\frac{40}{12}\right)$$

$$v\left(\frac{4.16 - 4.08}{4.08 \times 4.16}\right) = \left(\frac{40}{12}\right)$$

$v = 707.2 \approx 707 m/s$

Question: Work function of metal is $6.63 \times 10^{-19} J$ .then the maximum wavelength to remove photoelectrons in nm

Options:

(a) 100 nm

(b) 400 nm
(c) 600 nm
(d) 300 nm

Answer: (d)

Solution: $\phi = 6.63\times10^{-19}\text{g}$

$$\phi_{\text{in(ev)}} = \frac{6.63\times10^{-19}}{1.6\times10^{-19}}\text{eV}$$

$$= 4.14\text{eV}$$

We know

$$\phi = \frac{1240}{\lambda_{\text{in nm}}}$$

$$\lambda_{\text{(in nm)}} = \frac{1240}{\phi_{\text{in ev}}}$$

$$= \frac{1240}{4.14}$$

$$= 299.516 \approx 300\text{nm}$$

Question: A drop which has radius of 2 cm is broken into 64 different drops find the gain in potential energy. Surface tension of water is 0.075 N/m

Options:

(a) 1.1 milli joules
(b) 1.3 milli Joules
(c) 11.3 milli joules
(d) 1.13 milli Joules

Answer: (d)

Solution: $\frac{4}{3}\times\left(2\times10^{-2}\right)^3 = 64\times\frac{4}{3}\pi\left(\text{r}^3\right)$

$$\text{r} = \frac{2\times10^{-2}}{4}$$

$$\text{r} = 5\times10^{-3}\,\text{m}$$

Change in surface energy $= 5\times\text{A}_{\text{big}} - 5\times\text{A}_{\text{small}}$

$$= 0.075\times4\pi\left(2\times10^{-2}\right)^2 - 0.075\times4\pi\times\left(5\times10^{-3}\right)^2\times64$$

$$= 1.13\,\text{milli joules}$$

Question: Human voice lower hearing limit.
High quality music
Earth wave
Radio wave

Options:

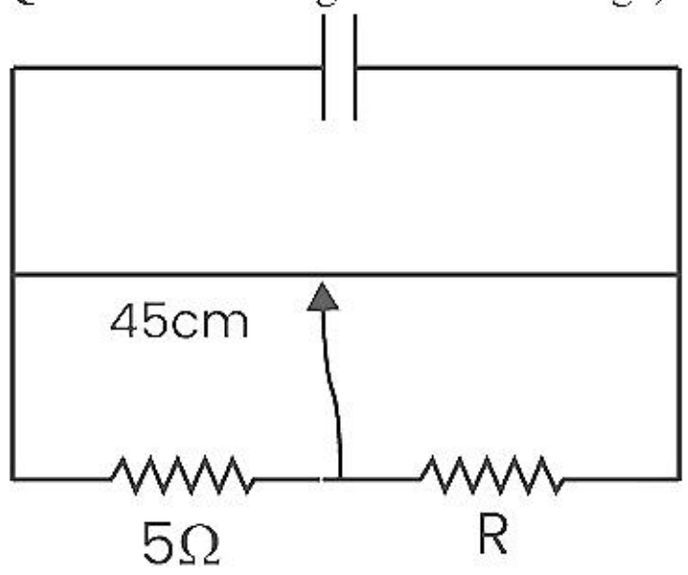
(a) 20 Hz, 440 Hz, 8 Hz, 330 kHz to 300 GHz
(b) 20 Hz, 440 Hz, 8 Hz, 130 kHz to 200 GHz
(c) 10 Hz, 40 Hz, 4 Hz, 330 kHz to 300 GHz
(d) 20 Hz, 40 Hz, 2 Hz, 330 kHz to 100 GHz

Answer: (a)

Solution: Human voice lower hearing limit $\rightarrow 20\text{Hz}$
High quality music $\rightarrow 440\text{Hz}$

Earth wave $\rightarrow$ 8Hz
Radio wave $\rightarrow$ 300kHz to 300 GHz

Question: In the given meter bridge, Find the vale of R



Options:

(a) $45/3\Omega$

(b) $55/3\Omega$

(c) $35/3\Omega$

(d) $25/3\Omega$

Answer: (b)

Solution:

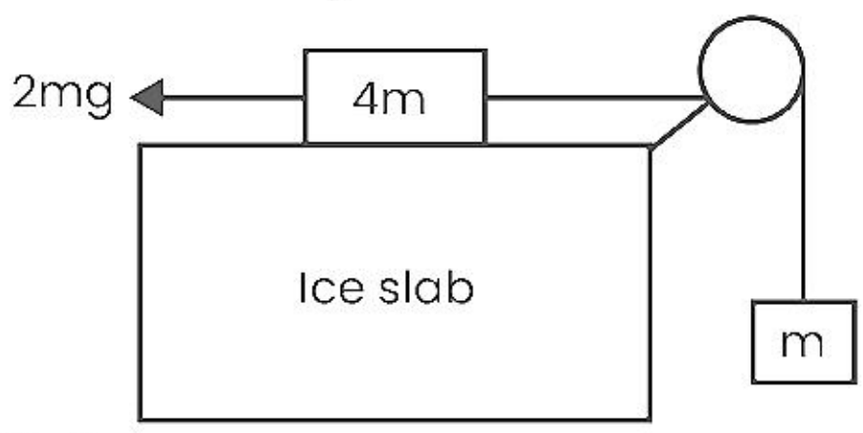
As we have obtained null direction at 45 cm. Hence

$$\frac{15}{45}=\frac{R}{(100-45)}$$

$$\frac{15}{45}=\frac{R}{55}$$

$$R=\frac{55}{3}\Omega$$

Question: If $T=\frac{x}{5}mg$ Find x = ?



Options:

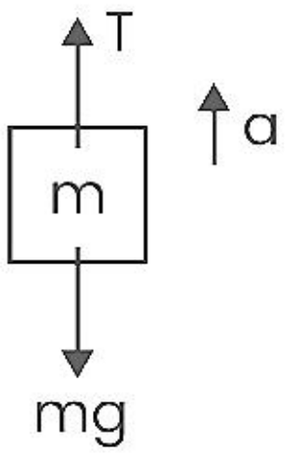
(a) 6

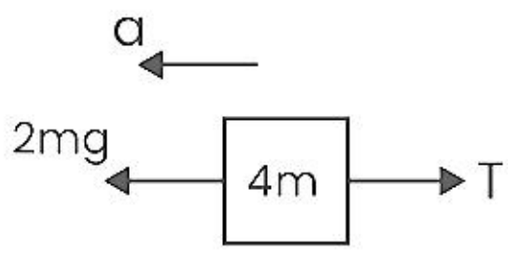
(b) 5

(c) 7

(d) 9

Answer: (a)
Solution:





2mg - T = 4ma

$T - mg = ma(1)$

$\text{from eq}(1)\text{in eq}(2)$

$2mg - T = 4(T - mg)$

$5T = 6mg$

$T = \frac{6}{5}mg$

$Hence\, x = 6$

Question: MOI of sphere about tangent
MOI of disc about disc about diameter
MOI of ring about diameter
Options:

(a) $\frac{2MR^2}{3}$

(b) $\frac{3MR^2}{2}$

(c) $\frac{MR^2}{3}$

(d) MR^2

Answer: (a)
Solution:

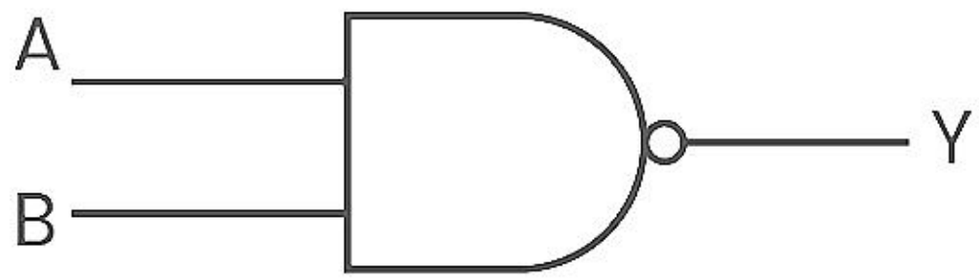
MOI of sphere about tangent $\frac{7}{5}MR^2$

MOI of disc about diameter $= \frac{MR^2}{4}$

MOI of ring about diameter $= \frac{MR^2}{2}$

MOI of hollow sphere a from axis passing through center $= \frac{2MR^2}{3}$

Question: For the following gate the output Y is given by



Options:

(a) A + B

(b) $\overline{A+B}$

(c) A. B

(d) $\overline{A.B}$

Answer: (d)

Solution:

It is a NAND Gate hence the answer is d.

Question: A particle moves in x-y plane according to rule $x = A\cos(\omega t), Y = A\sin(\omega t)$. The particle follows:

Options:

(a) An elliptical path

(b) A circular path

(c) A parabolic path

(d) A straight-line path inclined equally to x and y-axis

Answer: (b)

Solution: $x = A\sin\omega t$ or $\frac{x}{A} = \sin\omega t$ ....(i)

$y = A\cos\omega t$ or $\frac{y}{A} = \cos\omega t$ ....(ii)

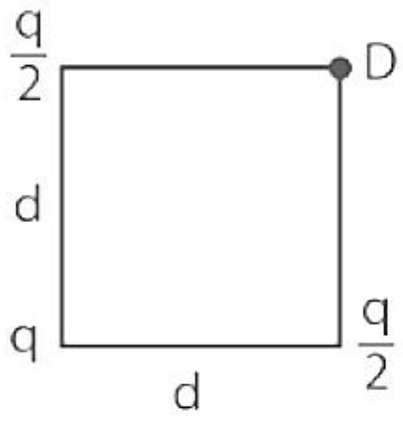
Squaring and adding, we get

$\frac{x^2}{A^2} + \frac{y^2}{A^2} = 1\left(\because \cos^2\omega t + \sin^2\omega t = 1\right)$

Or $x^2 + y^2 = A^2$

This is the equation of a circle. Hence particle follows a circular path.

Question:



Find electric field at point D?

Options:

(a) $\left(\sqrt{2}+1\right)\frac{Kq}{2d^2}$

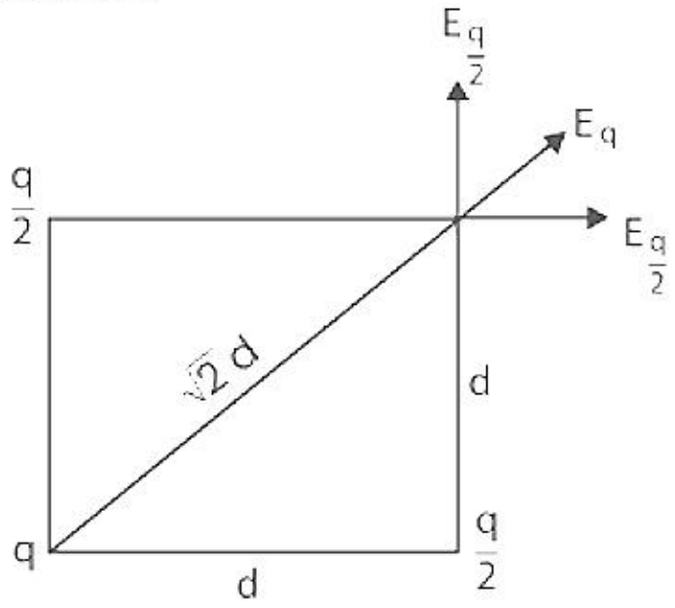
(b) $\frac{Kq}{2d^2}$

(c) $(2+1)\frac{Kq}{2d^2}$

(d) $\sqrt{2}\frac{Kq}{2d^2}$

Answer: (a)

Solution:



$$\vec{E}_{\frac{q}{2}} = \frac{k\frac{q}{2}}{d^2}\hat{i}$$

$$\vec{E}_{\frac{q}{2}} = \frac{k\frac{q}{2}}{d^2}\hat{j}$$

Resultant of electric fields due to $\frac{q}{2}$ will be in direction of field due to q.

$$\left|\vec{E}_R\right| = \sqrt{\left(\frac{kq}{2d^2}\right)^2 + \left(\frac{kq}{2d^2}\right)^2}$$

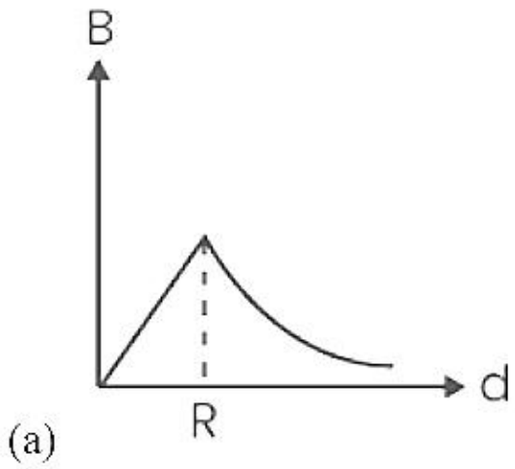
$$E_R = \sqrt{2}\frac{kq}{2d^2}$$

$$E_q = \frac{kq}{\sqrt{2}d^2} = \frac{kq}{2d^2}$$

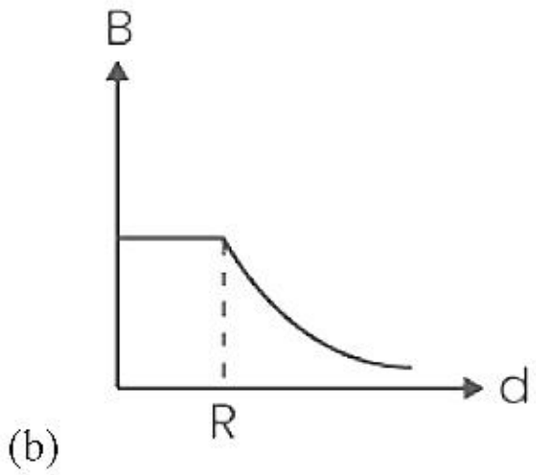
$$E_{total} = \left(\sqrt{2}+1\right)\frac{kq}{2d^2}$$

Question: A uniform current is flowing along the length of an infinite, straight, thin, hollow cylinder of radius 'R'. The magnetic field 'B' produced at a perpendicular distance 'd' from the axis of the cylinder is plotted in a graph. Which of the following figures looks like the plot?

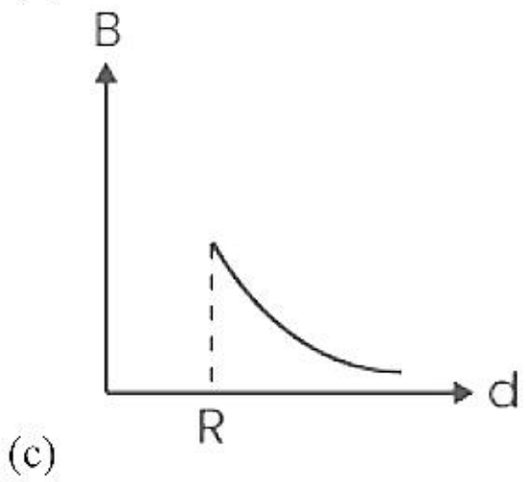
Options:



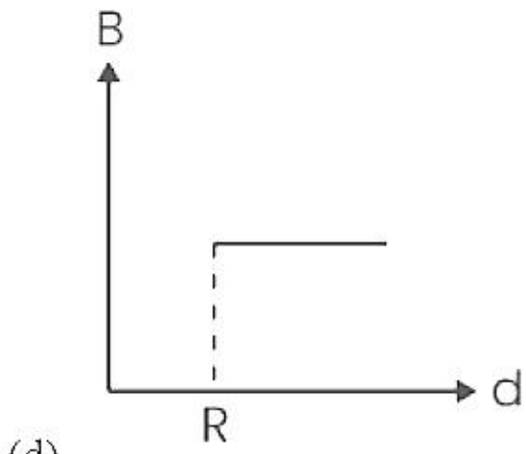
(a)



(b)



(c)



(d)

Answer: (c)

Solution: For

$d < R$

$B \times 2\pi d = \mu_0 I_{in} = 0$

As B=0

For $d > R$

$B \times 2\pi d = \mu_0 I$

$$B = \frac{\mu_0 I}{2\pi d}$$

Question: Read the assertion and reason carefully to mark the correct option out of the options given below.

Assertion: Dimensions of pressure × time is same as of coefficient of viscosity

Reason: Coefficient of viscosity $= \frac{\text{Force}}{\text{Velocity gradient}}$

Options:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true, but the reason is not the correct explanation of the assertion.

(c) If assertion is true, but reason is false.

(d) If both the assertion and reason are false.

Answer: (c)

Solution: Coefficient of viscosity, $\eta = \frac{F}{\frac{A dv}{dx}}$

$[F] = [\text{Force}] = MLT^{-2}$

$[A] = [\text{Area}] = L^2$

$\left[\frac{dv}{dx}\right] = [\text{Velocity gradient}] = \frac{LT^{-1}}{L} = T^{-1}$

$\therefore [\eta] = \frac{MLT^{-2}}{L^2T^{-1}} = \left[ML^{-1}T^{-1}\right]$

$[P] = \left[ML^{-1}T^{-2}\right]$

$[P] \times [T] = \left[ML^{-1}T^{-1}\right] = [\eta]$

So, Assertion is true but reason is false.

Question: A pendulum of length 250 cm is released from rest when string makes angle of 60° with vertical. Find its maximum velocity

Options:

(a) 2 m/s

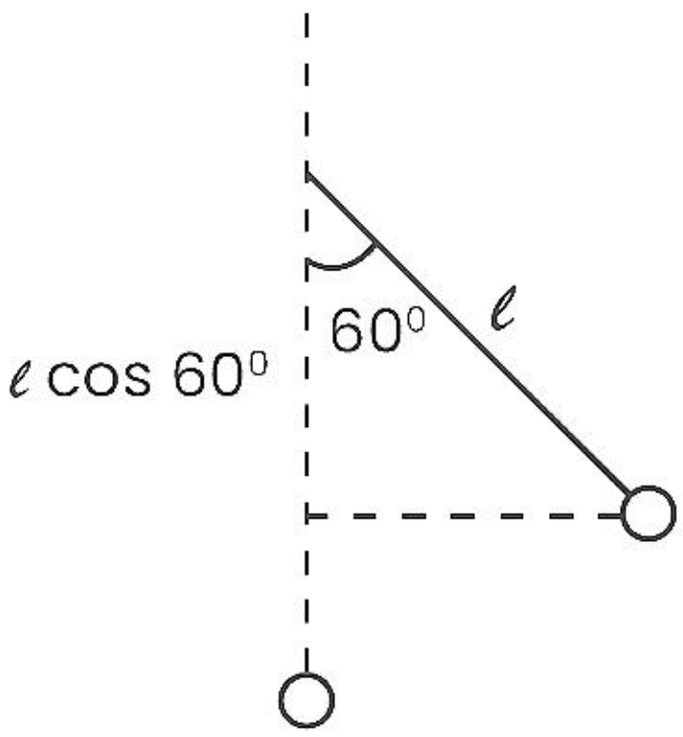
(b) 3 m/s

(c) 5 m/s

(d) 6 m/s

Answer: (c)

Solution:



$$mg\left(\ell - \ell\cos 60^\circ\right) = \frac{1}{2}mv^2$$

$$20(2.50 - 1.25) = v^2$$

$$v = \sqrt{25}$$

$$v = 5m/s$$

Question: If $\vec{r} = \left(3\hat{i} + \hat{j}\right)m, \vec{v} = \left(3\hat{j} - \hat{k}\right)m/s^{-1}$ $m = 1kg$, $\left|\vec{L}\right| = \sqrt{x}Nm - s$. Find the value of x.

Options:

(a) 50

(b) 61

(c) 110

(d) 91

Answer: (d)

Solution: $v = 5m/s$

$$\vec{L} = M\left(\vec{r} \times \vec{v}\right)$$

$$\vec{L} = 1\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 1 & 0 \\ 0 & 3 & -1 \end{vmatrix}$$

$$= \hat{i}(-1-0) - \hat{j}(-3-0) + \hat{k}(9-0)$$

$$\vec{L} = -\hat{i} + 3\hat{j} + 9\hat{k}$$

$$\left|\vec{L}\right| = \sqrt{1^2 + 3^2 + 9^2} = \sqrt{91}$$

$$x = 91$$

Question: The period of two planets A and B is $T_A = 2T_B$. Find the ratio of radius of their revolution.

Options:

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

(b) $4^{\frac{1}{3}}$

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

(d) $6^{\frac{1}{3}}$

Answer: (b)

Solution:

$T^2 \propto r^3$

$T_A^2 \propto r_A^3$

$T_B^2 \propto r_B^3$

$$\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3$$

$$\frac{r_A}{r_B} = 4^{\frac{1}{3}}$$

Question: Read the assertion and reason carefully to mark the correct option out of the options given below.

Assertion: Work done by n mole of gas in adiabatic process is $w = \frac{nR(T_2 - T_1)}{1-\gamma}$

Reason: If work is done on a gas, then temperature will increase.

Options:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true, but the reason is not the correct explanation of the assertion.

(c) If assertion is true, but reason is false.

(d) If both the assertion and reason are false.

Answer: (c)

Solution: Assertion is true because this is the correct expression for work done in adiabatic process.

Reason is false because this is not true for many cases like for isothermal process temperature remains constant.

Question: Resolving power of a telescope for the aperture 24.4 cm for the wavelength $\lambda = 2440\,\text{Å}$ is

Options:

(a) 1.2×10^5

(b) 2.2×10^5

(c) 8.2×10^5

(d) 6.2×10^5

Answer: (c)

Solution: $\frac{1}{R.P} = \frac{1.22\lambda}{a}$

$$R.P = \frac{24.4\times10^{-2}}{1.22\times24\times2440\times10^{-10}} = 0.082\times10^7$$

$R.P = 8.2\times10^5$

Question: Centripetal acceleration is given by $= k^2rt^2$ if radius is constant then find the power delivered by the force

Options:

(a) mk^2r^2t

(b) m^2kr^2t

(c) mkr^2t

(d) $mkrt$

Answer: (a)

Solution: Centripetal acceleration, $a_c = k^2rt^2$

Where, $a_c = \frac{v^2}{r}$

$\Rightarrow \frac{v^2}{r} = k^2rt^2$

$\Rightarrow v = krt \ldots.(1)$

Tangential acceleration, $a_t = \frac{dv}{dt} = kr \ldots.(2)$

Tangential force acting on the particle, $F = ma_t = mkr$

Power delivered, $P = \bar{F}.\bar{v} = Fv\cos\theta$

$\therefore P = Fv = (mkr) \times krt (\because \theta = 0°)$

$\Rightarrow P = mk^2r^2t$