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JEE MAIN (JAN) 2023 (29-01-2023-Session-1)

Memory Based Question Paper

PHYSICS

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JEE-Main-29-01-2023 (Memory Based)
[Morning Shift]

Physics

Question: A projectile was projected at an angle θ = 30°, then find the ratio of kinetic energy at a starting point to the kinetic energy at highest point.

Options:

(a) $\frac{\sqrt{3}}{2}$

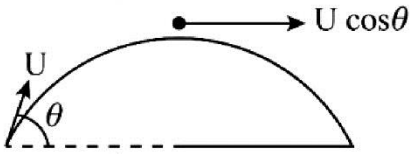
(b) $\frac{3}{2}$

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

(d) $\frac{2}{\sqrt{3}}$

Answer: (c)

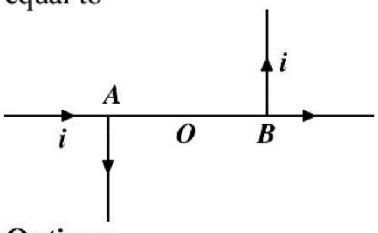
Solution:



$$\frac{K=\frac{1}{2}mu^2}{K'=\frac{1}{2}m\left(4\frac{\sqrt{3}}{2}\right)^2}$$

$$\frac{K}{K'}=\frac{4}{3}$$

Question: Point 0 and two long wires are kept in same plane such that point 0 lies at middle of the line. Then magnetic field at point 0 due to the current i flowing in both the wires is equal to



Options:

(a) $\frac{\mu_0 i}{2\pi l}$

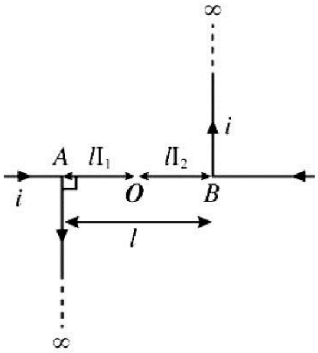
(b) $\frac{\mu_0 i}{\pi l}$

(c) $\frac{2\pi\mu_0 i}{l}$

(d) $\frac{\mu_0 i}{2l}$

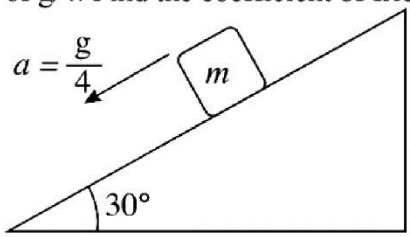
Answer: (b)

Solution:



$$B = \frac{2 \times \mu_0 I}{2\mu\pi\left(\frac{l}{2}\right)} = \frac{\mu_0 I}{\pi l}$$

Question: A block is sliding down an inclined plane of inclination 30° with an acceleration of g/4. Find the coefficient of friction between the block and incline



Options:

(a) $\frac{1}{\sqrt{3}}$

(b) $\frac{1}{2\sqrt{3}}$

(c) 1/3

(d) 1/2

Answer: (b)

Solution:

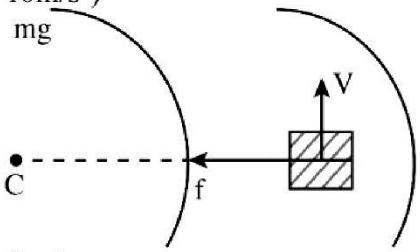
$a = g\sin\theta - Mg\cos\theta$

$$\frac{g}{4} = \frac{g}{2} - \mu g\frac{\sqrt{3}}{2}$$

$$\frac{\sqrt{3}}{2}\mu g = \frac{g}{4}$$

$$\mu = \frac{1}{2\sqrt{3}}$$

Question: A car is moving on a circular track of radius 50 cm with coefficient of friction being 0.34. On this horizontal track the maximum safe speed for turning is equal to (g = $10 m/s^2$)



Options:
(a) 1.03
(b) 1.7
(c) 1.3
(d) 1.8
Answer: (c)
Solution:

$$f = \frac{mV^2}{R} \le \mu mg$$

$$V \le \sqrt{\mu Rg}$$

$$V_{max} = \sqrt{m\,Rg} = \sqrt{0.34 \times 0.5 \times 10} = \sqrt{1.7} = 1.3$$

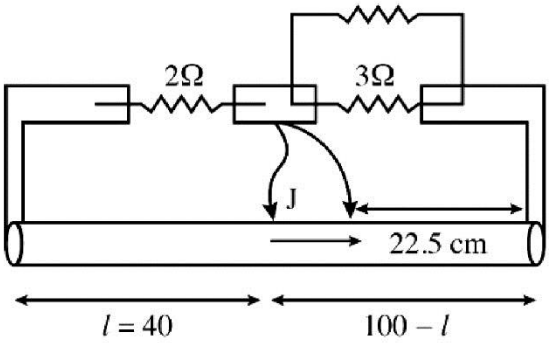
Question: Two resistors R and 3R are in parallel, find the ratio of power dissipated in them.
Options:
(a) 1 : 2
(b) 2 : 1
(c) 3 : 1
(d) 1 : 3
Answer: (c)
Solution:

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

$$P \propto \frac{1}{R}$$

$$\frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{3R}{R}$$

Question: In a meter bridge experiment, null point is found at a particular paint for resistance 2 Ω and 3 Ω. Then resistance of X Ω is shunted on 3 Ω resistor, and null point shifts by 22.5 cm. Then find the value of X.



Options:
(a) 1
(b) 2
(c) 3
(d) 4
Answer: (b)
Solution:

$$\frac{2}{3}=\frac{l}{100-i}\Rightarrow 200-2l=3l$$

$$l=40cm$$

Finally, after attaching X in parallel with 3Ω

$$\text{New Resistance}=\frac{3x}{x+3}$$

$$\text{So }\frac{2}{\left(\frac{3x}{x+3}\right)}=\frac{40+22.5}{60-22.5}=\frac{62.5}{37.5}=2\Omega$$

Question: Find the ratio of maximum wavelength of Lyman series of Hydrogen atom to minimum wavelength of Balmer series of Helium atom.
Options:
(a) 4/3
(b) 1
(c) 3/2
(d) 3/4
Answer: (a)
Solution:

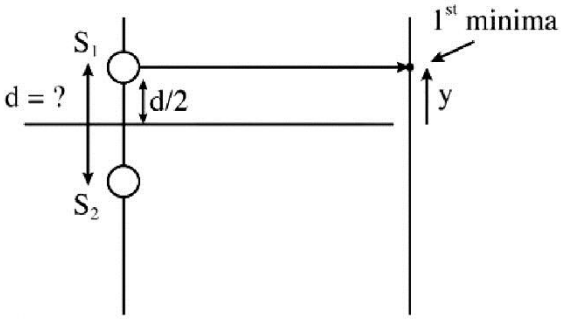
$$\frac{1}{\lambda} = R\left[\frac{1}{n_f^2 - \frac{1}{n_i^2}}\right] Z^2$$

$$\frac{1}{\lambda_1} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] \times 1^2$$

$$\frac{1}{\lambda_2} = R\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] \times 2^2$$

$$\frac{\lambda_1}{\lambda_2} = \frac{4}{3}$$

Question: In YDSE 1st minima is formed directly opposite to upper slit, then find d (λ = 800 nm, D = 5 cm)



Options:

(a) 0.4 mm

(b) 0.3 mm

(c) 0.2 mm

(d) 0.1 mm

Answer: (c)

Solution:

$$\frac{d^2}{2D} = \frac{\lambda}{2}$$

$$d = \sqrt{\lambda D}$$

$$\Delta x = \frac{dy}{D} = \frac{d(d/2)}{D}$$

Question: Two objects of equal mass m are moving in a circular path of radius "r" are because of their mutual gravitational attraction force. Find the velocity of each particle.

Options:

(a) $\sqrt{\frac{Gm}{r}}$

(b) $\sqrt{\frac{Gm}{2r}}$

(c) $\sqrt{\frac{Gm}{4r}}$

(d) $\sqrt{\frac{2Gm}{r}}$

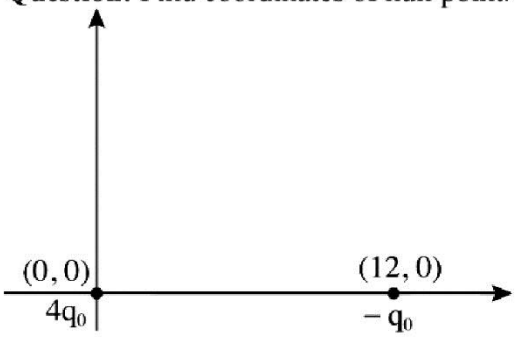
Answer: (c)

Solution:

$$F = \frac{Gm^2}{4r^2} = \frac{Mv^2}{r}$$

$$V = \sqrt{\frac{Gm}{4r}}$$

Question: Find coordinates of null point.



Options:

(a) (12, 0)

(b) (0, 12)

(c) (0, 24)

(d) (24, 0)

Answer: (d)

Solution:

$$x = \frac{d}{\sqrt{\frac{|\theta_{Big}|}{|\theta_{Small}|}} - 1} = \frac{d}{\sqrt{\frac{4q_0}{q_0}}} = d$$

$$\frac{k(q_0)}{x^2} = \frac{k(4q_0)}{(d+x)^2}$$

Question: A soap bubble of Radius R & surface tension S is blown to double the radius. Find charge in surface energy.

Options:

(a) $24\pi SR^2$

(b) $12\pi SR^2$

(c) $6\pi SR^2$

(d) $3\pi SR^2$

Answer: (a)

Solution:

$$U_i = \left(S \times 4\pi R^2\right) \times 2$$

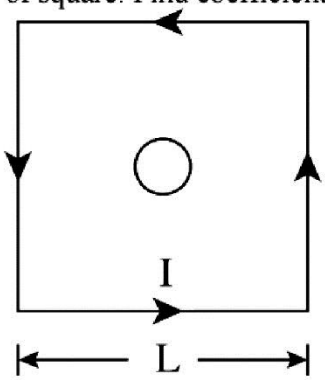
$$U_i = 8\pi SR^2$$

$$U_{final} = S \times 4\pi \left(2R\right)^2 \times 2$$

$$U_f = 32S\pi R^2$$

$$\Delta U = 24\pi SR^2$$

Question: There is square loop of length 'L'. A very small ring of radius r is placed at centre of square. Find coefficient of mutual inductance.

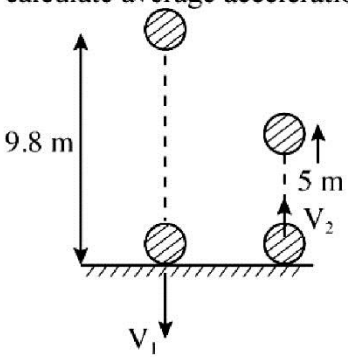


Solution:

$$B = \frac{\mu_o i_1}{4\pi \frac{L}{2}} \left(\frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}}\right) \times \pi r^2$$

$$\phi_{2,1} = \left[\frac{2\sqrt{2}\mu_0 r^2}{L}\right] i_1$$

Question: A Tennis ball is dropped from 9.8 m it hits the ground and rebounds to 5m calculate average acceleration at point of contact t = 0.2 sec



Options:

(a) 50 m/s^2

(b) 120 m/s^2

(c) 100 m/s^2

(d) 200 m/s^2

Answer: (b)

Solution:

$V_1 = \sqrt{2gh} = \sqrt{2\times10\times9.8} = 14\ \text{ms}^{-1}$

$V_2 = \sqrt{2\times10\times5} = 10\ \text{ms}^{-1}$

$\vec{a} = \frac{\Delta\vec{v}}{t} = \frac{\left(10\hat{i}\right)-\left(-14\right)\hat{j}}{0.2} = \frac{240}{2}\hat{j} = 120\hat{j}$

$= 120\ \text{ms}^{-1}$

Question: Match quantities with correct dimensions.

Column A	Column B
1. Latent Heat	(p) $MLA^{-1}T^{-3}$
2. Electric field	(q) $ML^{-2}T^{-2}$
3. Pressure Gradient	(r) $ML^2A^{-1}T^{-3}$
4. Electric Potential	(s) L^2T^{-2}

Options:

(a) 1-s, 2-p, 3-q, 4-r

(b) 1-p, 2-s, 3-q, 4-r

(c) 1-s, 2-p, 3-r, 4-q

(d) 1-q, 2-p, 3-s, 4-r

Answer: (a)

Solution:

$L = \frac{Q}{m} = \frac{ML^2T^{-2}}{M}$

$E = \frac{F}{q} = \frac{MLT^{-2}}{AT}$

$\frac{dP}{dx} = \frac{ML^{-1}T^{-2}}{L} = ML^2T^{-2}$

$V = \frac{P.E.}{2} = \frac{ML^2T^{-2}}{AT}$

Question: A nucleus $^{236}X_{92}$ undergoes two α decays and one β^- decay. Find atomic number and mass number.

Options:

(a) Z = 88, Z = 227

(b) Z = 90, Z = 225

(c) Z = 89, Z = 228

(d) Z = 81, Z = 210

Answer: (c)

Solution:

$X \xrightarrow{\alpha} X' \xrightarrow{\alpha} X''$

Question: A wire has been made into a circle and placed in constant magnetic field. If the radius of wire starts decreasing at rate of 2 cm/s when wire starts shrinking, find the EMF induced in the wire when radius of wire is 10 cm. Magnetic field strength in the region is 0.8 T.

Options:

(a) 0.01 V
(b) 0.1 V
(c) 1 V
(d) 10 V
Answer: (a)
Solution:
Flux via circular wire is given by

$\phi = \mathrm{B}.\pi \mathrm{r}^2$

So emf induced $|\varepsilon| = \left|\frac{d\phi}{dt}\right| = B.2\pi r\left|\frac{dr}{dt}\right|$

$= 0.8 \times 2\pi \times \frac{10}{100} \times \frac{2}{100}$

$= \frac{3.2\pi}{1000} \approx \frac{10}{1000} = \frac{1}{100}\,\mathrm{V}$

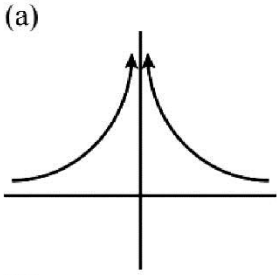
Question: Two antenna's has height 80 m, what is the range to which signal can be transmitted?
Options:
(a) 28 km
(b) 10 km
(c) 64 km
(d) 51 km
Answer: (c)
Solution:

$d^2 + R^2 = (R+h)^2$

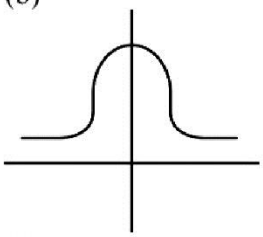
$d^2 + R^2 = R^2 + h^2 + 2Rh$

$d = \sqrt{2Rh}$

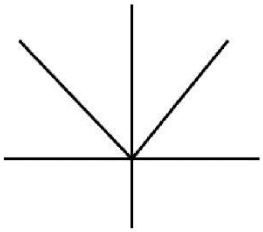
Question: Graph of Magnetic field of Ring in *xy* plane. At point 0, a, z Vs. z axis.
Options:
(a)



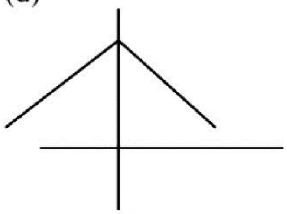
(b)



(c)



(d)



Answer: (b)

Solution:

$$B = \frac{\mu_0 i r^2}{2\left(r^2 + x^2\right)^{3/2}}$$

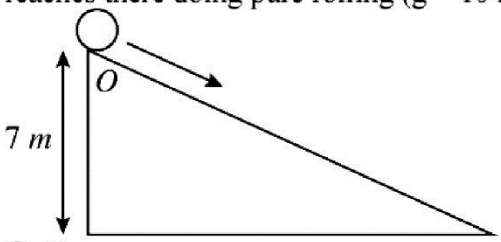
$$B = \frac{\mu_0 i r^2}{2}\left[r^2 + x^2\right]^{-3/2}$$

$$\frac{dB}{dx} = \frac{k\left(\frac{-3}{2}\right)}{\left(x^2 + r^2\right)^{5/2}}[2x]$$

Question: Cuboid of dimensions 2L × 2L × L, A charge q is placed at centre for of S with area 4L2 flux through opposite side is?

Solution: $q / 6\varepsilon_0$

Question: A solid sphere is released from point 0 at the top of an incline as shown. Find the value of velocity of centre of mass of sphere at the bottom most point of the incline after it reaches there doing pure rolling (g = 10 m/s^2)



Options:

(a) 3 m/s

(b) 7 m/s

(c) 10 m/s

(d) 0.7 m/s

Answer: (c)

Solution:

Big cube of side = 2L

$$= \frac{Q}{6\varepsilon_0}$$

Question: KE of a solid sphere is 4220 J on a horizontal plane. Find the velocity of COM of the sphere

Options:

(a) $40\sqrt{7}$

(b) $40\sqrt{3}$

(c) $30\sqrt{7}$

(d) $30\sqrt{3}$

Answer: (a)

Solution:

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\left(\frac{V^2}{R^2}\right)$$

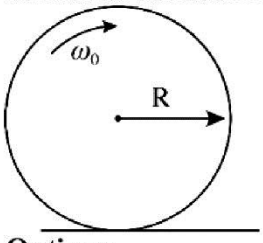
$$V = \sqrt{\frac{2gh}{1+\frac{I}{MR^2}}} = \sqrt{\frac{2\times10\times7}{1+\frac{2}{5}}} = \sqrt{\frac{20\times7\times5}{7}} = 10\ \text{ms}^{-1}$$

$$K = \frac{1}{2}mV^2 + \frac{1}{2}\left[\frac{2}{5}MR^2\right]\times\frac{V^2}{R^2}$$

$$K = \frac{7}{10}MV^2 = 2240$$

$$V^2 = \frac{112\times100}{7} = 40\text{ms}^{-1}$$

Question: A disk of radius R is given ω_0 angular speed and placed gently on a rough horizontal surface. Find the velocity of centre of disk when pure rolling starts.



Options:

(a) $\frac{R\omega_0}{3}$

(b) $R\omega_0$

(c) $\frac{R\omega_0}{4}$

(d) $2R\omega_0$

Answer: (a)

Solution:

$$L_i = L_f$$

$$\frac{MR^2}{2}\omega_0 = MRV + \frac{MRV}{2}$$

$$0 + \left[\frac{MR^2}{2}\omega_0\right] = (RMV) + \left[\frac{MR^2}{2}\omega\right](CLW)$$

$$\frac{MR^2}{2}\omega_0 = \frac{3}{2}MRV$$

$$V = \frac{R\omega_0}{3}$$

$$\vec{L} = M\left(\vec{r}_{com} \times \vec{v}_{com}\right) + I\vec{\omega}_{com}$$