PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 67

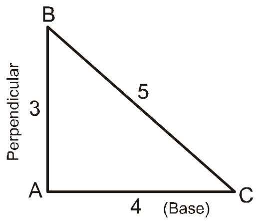
Total Marks : 24

Max. Time : 24 min.

Topics : Rotation, Center of Mass, Heat, Magnetic Effect of Current and Magnetic Force on Charge/ current, Gravitation, Rotation

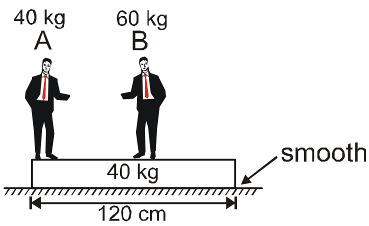
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. Moment of inertia of uniform triangular plate about axis passing through sides AB, AC, BC are I_P, I_B & I_H respectively & about an axis perpendicular to the plane and passing through point C is I_C. Then :



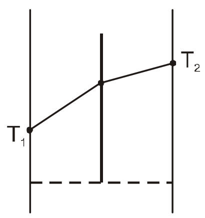
(A) $I_C > I_P > I_B > I_H$
(B) $I_H > I_B > I_C > I_P$
(C) $I_P > I_H > I_B > I_C$
(D) none of these

2. Two men 'A' and 'B' are standing on a plank. 'B' is at the middle of the plank and 'A' is at the left end of the plank. System is initially at rest and masses are as shown in figure. 'A' and 'B' start moving such that the position of 'B' remains fixed with respect to ground then'A' meets 'B'. Then the point where A meets B is located at :



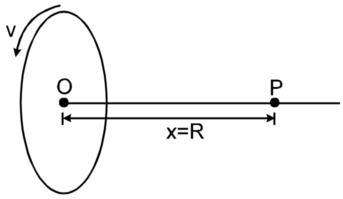
(A) the middle of the plank
(B) 30 cm from the left end of the plank
(C) the right end of the plank
(D) None of these

3. The wall of a house is made of two different materials of same thickness. The temperature of the outer wall is T_2 and that of inner wall is $T_1 < T_2$. The temperature variation inside the wall as shown in the figure. Then :



(A) thermal conductivity of inner wall is greater than that of outer.
(B) thermal conductivity of outer wall is greater than that of inner
(C) thermal conductivities of the two are equal
(D) no conclusion can be drawn about thermal conductivities

4. A uniformly charged ring of radius R is rotated about its axis with constant linear speed v of each of its particles. The ratio of electric field to magnetic field at a point P on the axis of the ring distant x = R from centre of ring is (c is speed of light)



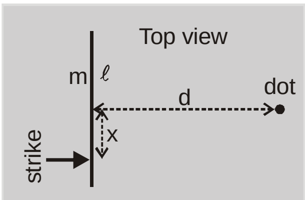
(A) $\frac{c^2}{v}$ (B) $\frac{v^2}{c}$ (C) $\frac{c}{v}$ (D) $\frac{v}{c}$

5. A satellite is revolving around earth in a circular orbit. At some instant the speed of the satellite is increased $\sqrt{2}$ times its orbital speed keeping its direction unchanged. Then, the new path of the satellite is :

(A) circular (B) straight line (C) elliptical (D) parabolic

COMPREHENSION

A thin uniform rod of length ℓ and mass m lies on a frictionless fixed horizontal surface. It is struck with a quick horizontal blow (directed perpendicular to the rod) at a distance x from the center of rod. A dot is painted on the horizontal surface at a distance d from the initial position of the center of the rod.



6. Let v be the speed of centre of mass and ω be the angular speed of the rod just after the blow. Then the value of $\frac{\omega}{v}$ is :

(A) $\frac{x}{\ell^2}$ (B) $\frac{3x}{\ell^2}$ (C) $\frac{4x}{\ell^2}$ (D) $\frac{12x}{\ell^2}$

7. For the rod to make one complete revolution by the time the center reaches the dot, the value of x (in terms of ℓ and d) should be :

(A) $\frac{\pi\ell^2}{2d}$ (B) $\frac{\pi\ell^2}{3d}$ (C) $\frac{\pi\ell^2}{6d}$ (D) $\frac{\pi\ell^2}{12d}$

8. For x as asked in previous question to exist, the minimum value of d (in terms of ℓ) should be :

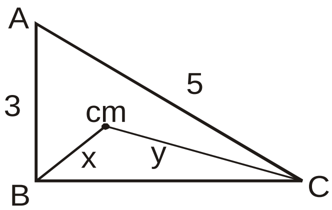
(A) $\frac{\pi\ell}{2}$ (B) $\frac{\pi\ell}{3}$ (C) $\frac{\pi\ell}{4}$ (D) $\frac{\pi\ell}{6}$

Answers Key

1.	(A)	**2.**	(C)	**3.**	(B)	**4.**	(A)
5.	(D)	**6.**	(D)	**7.**	(C)	**8.**	(B)

Hints & Solutions

1. Moment of inertia is more when mass is farther from the axis. In case of axis BC, mass distribution is closest to it and in case of axis AB mass distribution is farthest .Hence



$I_{BC} < I_{AC} < I_{AB}$

$\Rightarrow \quad I_P > I_B > I_H \qquad\qquad I_C \;=\; I_{CM} + my^2$

$= \quad I_B^1 - mx^2 + my^2$

$= \quad I_B^1 + m(y^2 - x^2) \qquad\qquad = \quad I_P + I_B + m(y^2 - x^2)$

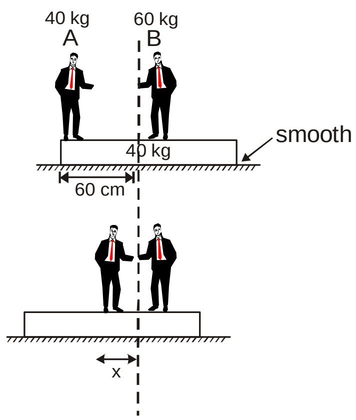
$> \quad I_P + I_B$

$> \quad I_P$

Here I_B^1 is moment of inertia of the plate about an axis perpendicular to it and passing through B.

$\therefore \quad I_C > I_P > I_B > I_H$

2. **(C)** Taking the origin at the centre of the plank.



$m_1\Delta x_1 + m_2\,\Delta x_2 + m_3\Delta x_3 = 0$

$(\because\ \Delta x_{CM} = 0)$

(Assuming the centres of the two men are exactly at the axis shown.)

$60(0) + 40(60) + 40(-x) = 0$, x is the displacement of the block.

$\Rightarrow \quad x = 60$ cm

i.e. A & B meet at the right end of the plank.

3. The slope of temperature variation is more in inner

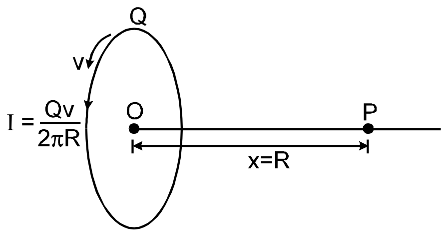
$$\frac{dQ}{dt} = \frac{KA}{\ell}.\Delta T$$

$$\Delta T = \frac{\ell}{KA}.\frac{dQ}{dt}$$

Slope $\alpha \frac{1}{K}$

Larger the conductivity, smaller is the slope.

4. Let Q be the charge on the ring. The electric field at point P is



$$\therefore \quad E = \frac{1}{4\pi \epsilon_0} \frac{Qx}{(x^2 + R^2)^{3/2}}$$

$$= \frac{1}{4\pi \epsilon_0} \frac{QR}{(2R^2)^{3/2}}$$

The rotating charged (Q) ring is equivalent to a ring in which current I flows, such that

$$I = \frac{Qv}{2\pi R}$$

The magnetic field at point P is

$$B = \frac{\mu_0}{4\pi} \frac{2\pi I R^2}{(x^2 + R^2)^{3/2}} = \frac{\mu_0}{4\pi} \frac{QvR}{(2R^2)^{3/2}}$$

$$\therefore \quad \frac{E}{B} = \frac{1}{\mu_0 \epsilon_0 v} = \frac{c^2}{v}$$

5. The orbital velocity,

$$v_0 = \sqrt{\frac{GM}{r}}$$

Its velocity is increased by $\sqrt{2}$ times, new velocity

$$v = \sqrt{2}\sqrt{\frac{GM}{r}} = \sqrt{\frac{2GM}{r}} = \text{escape velocity}$$

The path is parabolic in case of escape velocity.

8. $\Delta L = \int \tau dt = \int xFdt = x\Delta P$ (because x is essentially constant during the quick blow)

since, the rod starts at rest, the final values therefore satisfy L = xP.

$\Rightarrow \frac{1}{2}m\ell^2\omega = xmv \Rightarrow \frac{\omega}{v} = \frac{12x}{\ell^2}$ .... (1)

Another expression for $\frac{\omega}{v}$ is obtained from the given information that rod makes one revolution by the time centre reaches the dot.

$\omega t = 2\pi$ and $vt = d$

$\Rightarrow \frac{\omega}{v} = \frac{2\pi}{d}$ .... (2)

from equation 1 and 2 : $\frac{12x}{\ell^2} = \frac{2\pi}{d}$ $\therefore$ $x = \frac{\pi\ell^2}{6d}$

x cannot be larger than $\frac{\ell}{2}$

$\frac{\pi\ell^2}{6d} \le \frac{\ell}{2} \Rightarrow \frac{\pi\ell}{3} \le d$