PHYSICS

BOOKS - NCERT PHYSICS (HINGLISH)

SYSTEM OF PARTICLES AND ROTATIONAL MOTION

Multiple Choice Questions Mcqs

1. For which of the following does the centre of mass lie outside the body ?

A. A pencil

B. A shotput

C. A dice

D. A bangle

Answer: D

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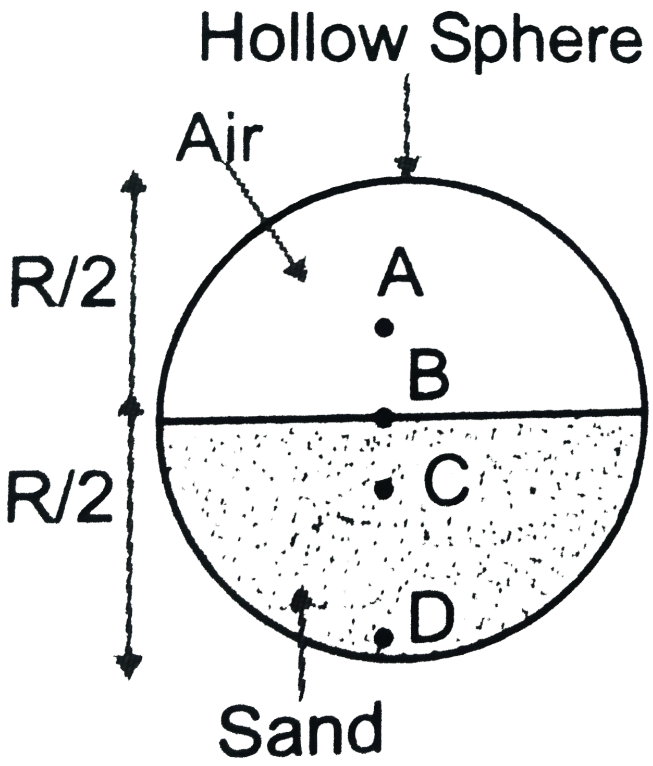
2. Which of the following points is the likely position of the centre of mass of the system

shown in Fig.



A. A

B. B

C. C

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Answer: C

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3. A particle of mass m is moving in YZ-plane with a uniform velocity v with its trajectory running parallel to $+ve$ Y-axis and intersecting Z-axis at $z = a$ in figure. The change in its angular momentum about the origin as it bounces elastically form a wall at

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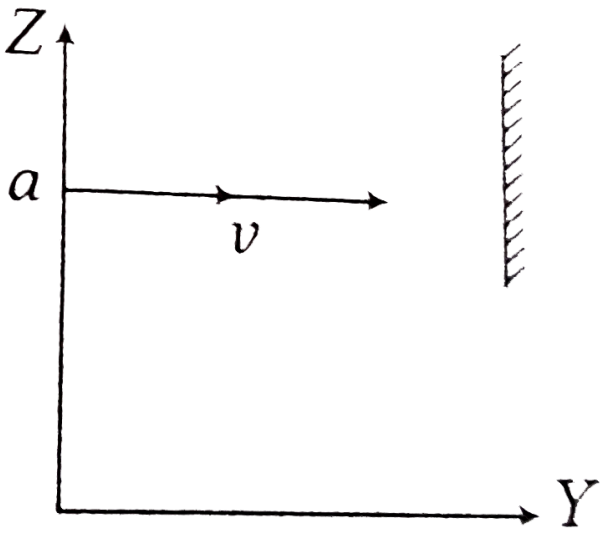

A. $mva\hat{e}_x$

B. $2mva\hat{e}_x$

C. $ymv\hat{e}_x$

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Answer: B

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4. When a disc rotates with uniform angular velocity, which of the following is not true ?

A. the sence of rotation remains same

B. the orientation of the axis of ration remains same

C. the speed of rotation in non - zero and remains same

D. the angular acceleration is non- zero and remains same

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5. A uniform square plate has a small piece Q of an irregular shape removed and guled to the centre of the plate leaving a hole behind

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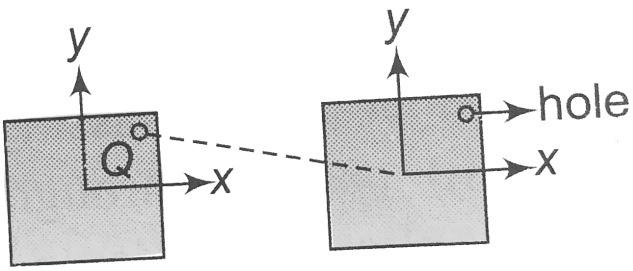

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6. In problem $5, theCM$ of the plate is now in the following quadrant of $x - y$ plane.

A. I

B. II

C. III

D. IV

Answer: c

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7. The density of a non-uniform rod of length $1m$ is given by $\rho(x) = a\left(1 + bx^2\right)$ where a and b are constants and $0 \leq x \leq 1$.

The centre of mass of the rod will be at

A. $\dfrac{3(2+b)}{4(3+b)}$

B. $\dfrac{4(2+b)}{3(3+b)}$

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Answer: a

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A. 2ω

B. ω

C. $\frac{\omega}{2}$

D. 0

Answer: A

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A. For a general rotational motion , angular momentum L and angular velocity ω need not be parallel .

B. For a rotional motion about a fixed axis , angular momentum L and angular velocity $oemga$ are always parallel .

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Answer: A, C

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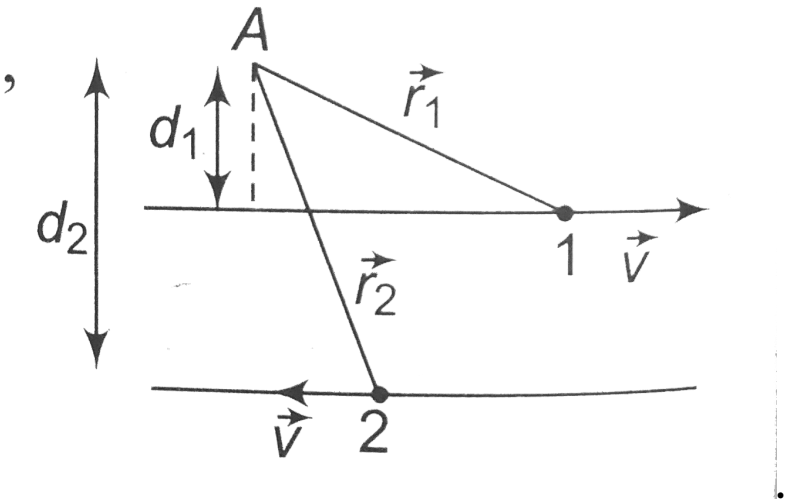

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11. The net external torque on a system of particles about an axis is zero. Which of the following are compatible with it ?

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12. Figure shows a lamina in $x - y$ plane. Two axes z and z' pass perpendicular to its plane. A force F acts in the plane of lamina at point P as shown. Which of the following statements is incorrect ?

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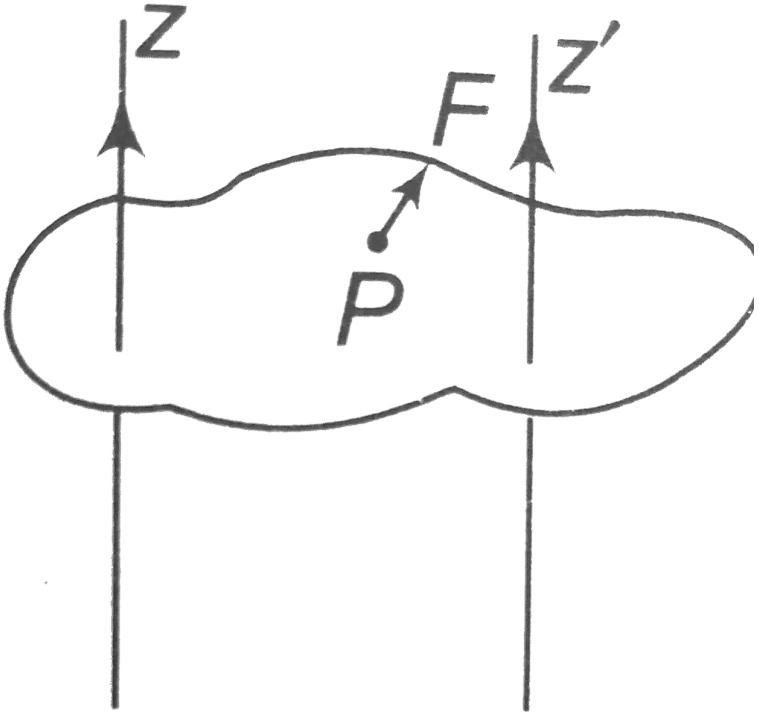

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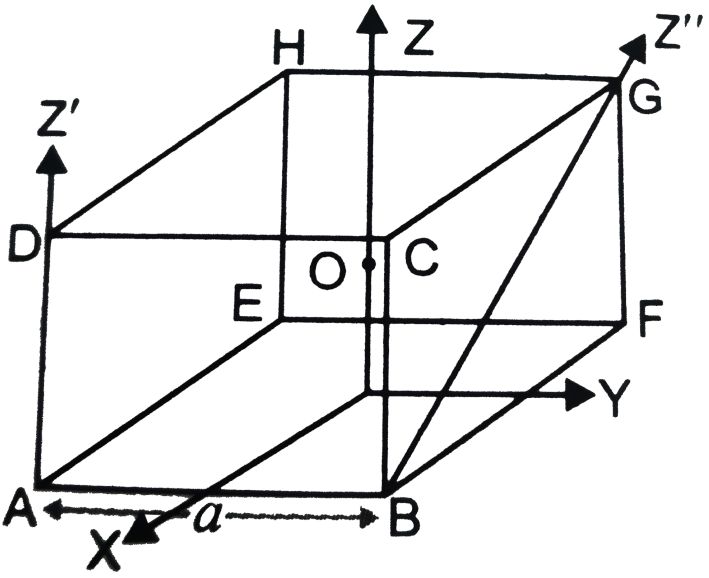

A. the moment of inertia of cube about z-axis is $I_z = I_x + I_y$

B. the moment of inertia of cube about z-axis is $I_z = I_z + \frac{ma^2}{2}$

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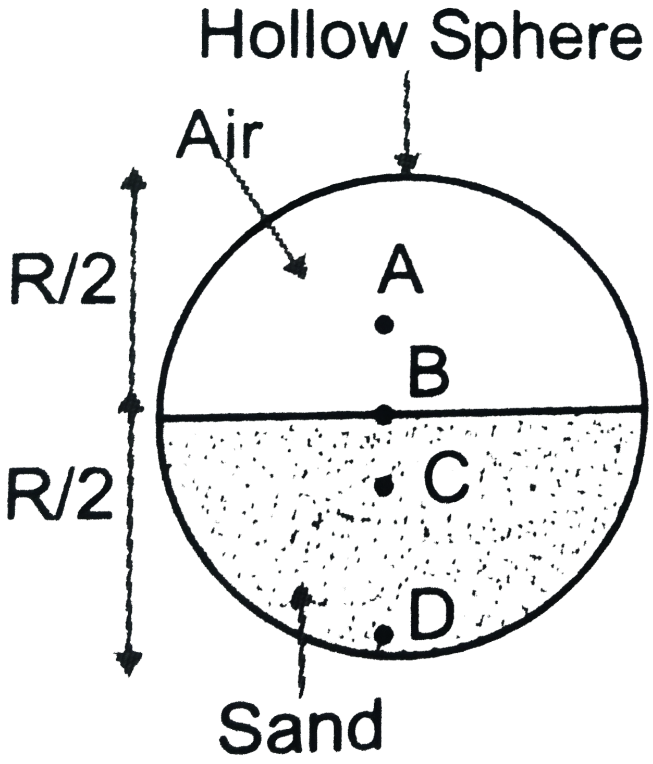

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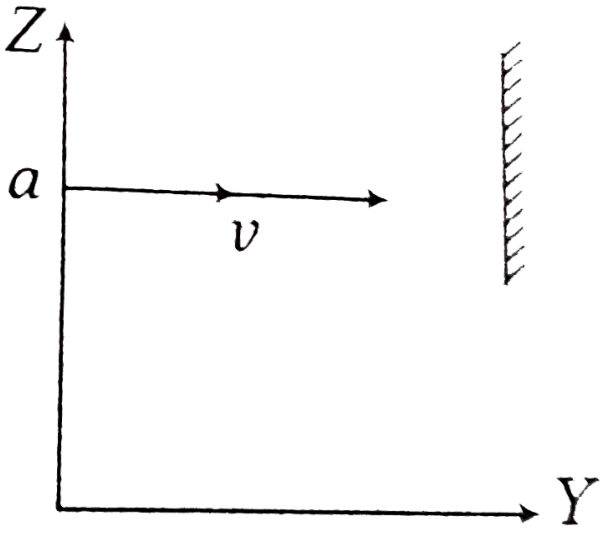

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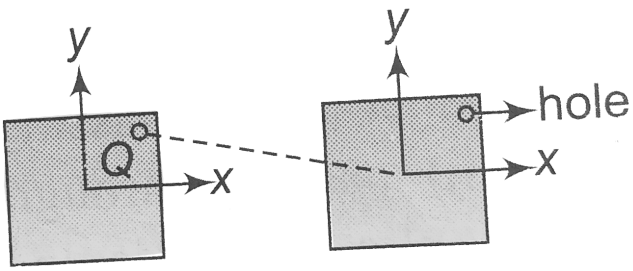

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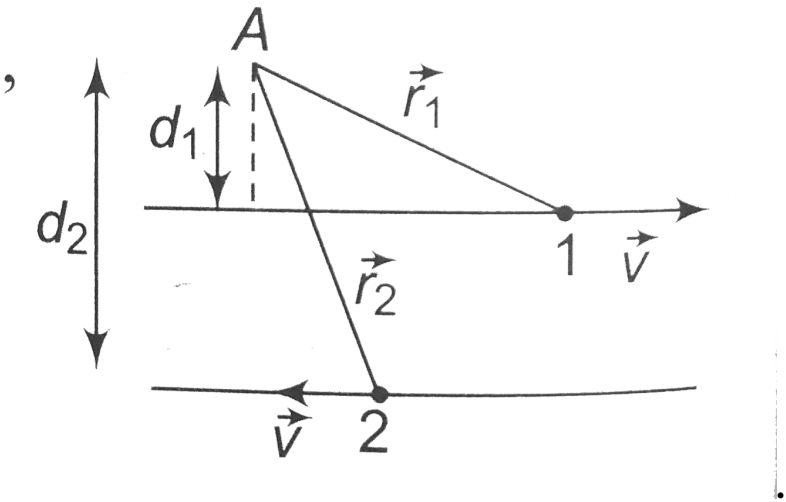

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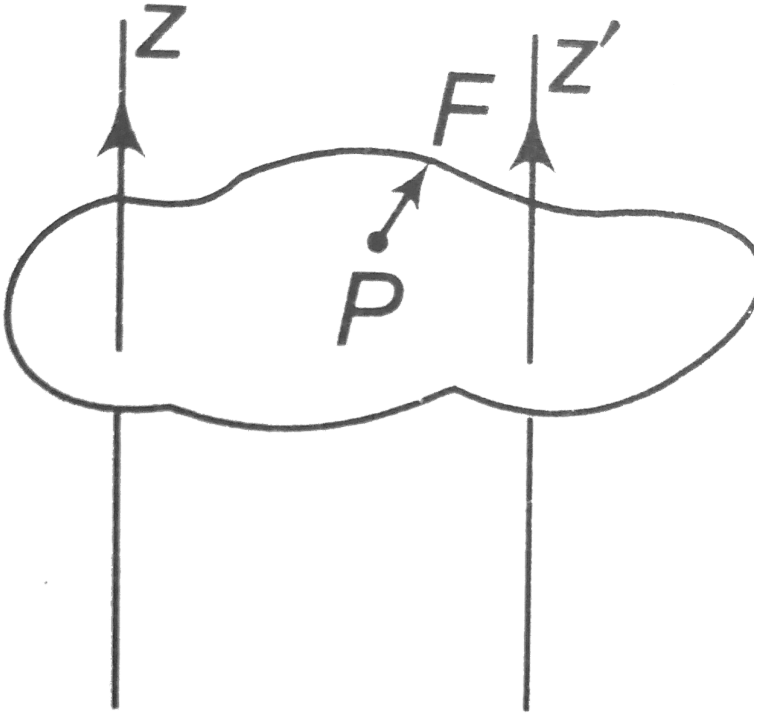

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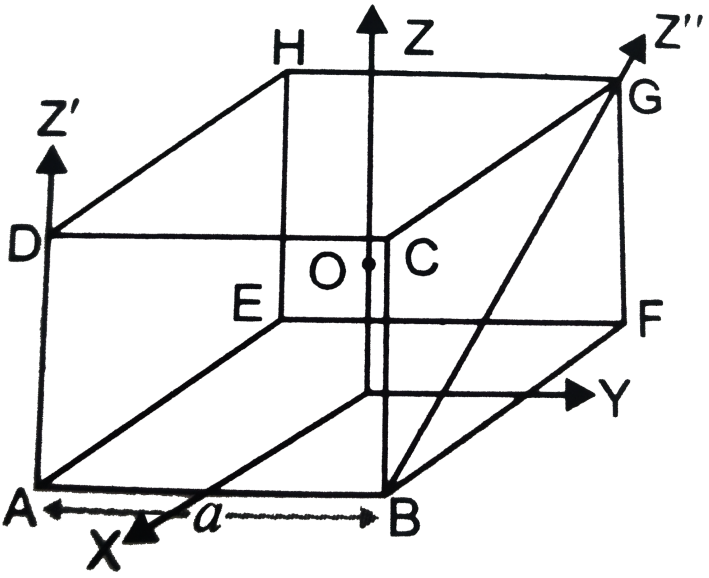

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Very Short Answer Type Questions

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for which of the following two coincides ? A building , a pond , a lake ,a mountain ?

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2. Why does a solid sphere have smaller moment of inertia than a hollow cylinder of

same mass and radius, about an axis passing through their axes of symmentry ?

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3. The variation of angular position θ, of a point on a rotating rigid body, with time t is shown in Fig. Is the body rotating clock wise or

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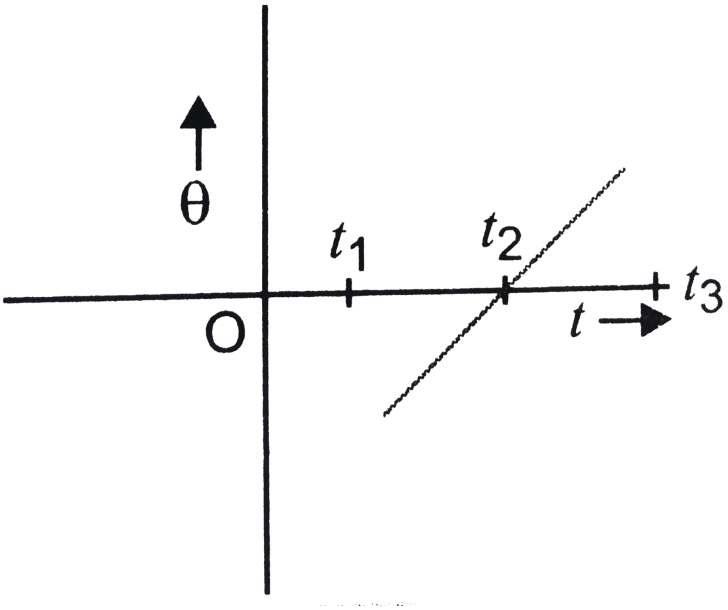

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4. A uniform cube of mass m and side a is placed on a frictionless horizontal surface. A vertical force F is applied to the edge as

shown in Fig. Match the following (most appropriate choice) :

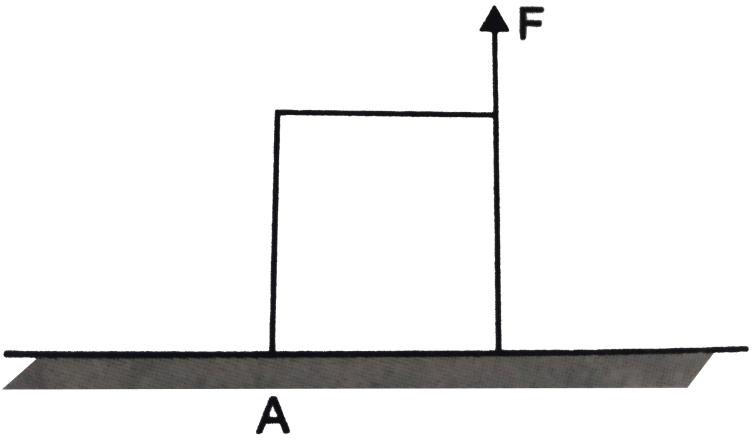
(a)$mg/4 < F < mg/2$ (i) Cube will move up.

(b) $F > mg/2$ (ii) Cube will not exhibit motion.

(c) $F > mg$ (iii) Cube will begin to rotate and slip at A.

(d) $F = mg/4$ (iv) Normal reaction effectively

at $a/3$ from A, no motion.



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5. A uniform sphere of mass m and radius R is placed on a rough horizontal surface. The spher is struck horizontally at a height h from the floor. Show that the sphere rolls without

slipping with a constant velocity, when $h = 7R/5$.

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6. The vector sum of a system of non-collinear forces acting on a rigid body is given to be non-zero. If the vector sum of all torques due to the system of forces about a certain point is found to be zero, does this mean that it is necessarily zero about any arbitrary point ?

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7. A wheel in uniform motion about an axis passing through its centre and perpendicular plus is considered to be in mechanical (translational plus rotational) equilibrium because no net external force or torqure is reqired to sustain its motion However , the particles than constitute the wheel do experience a centripeteal the acceleration wheel being in equilibrium ?

how would you set a half wheel into unifrom motion about an axis passing throgh the

centre of mass of the wheel and perpendicular to its plane ? will ypu require external forces to sustain the motion ?

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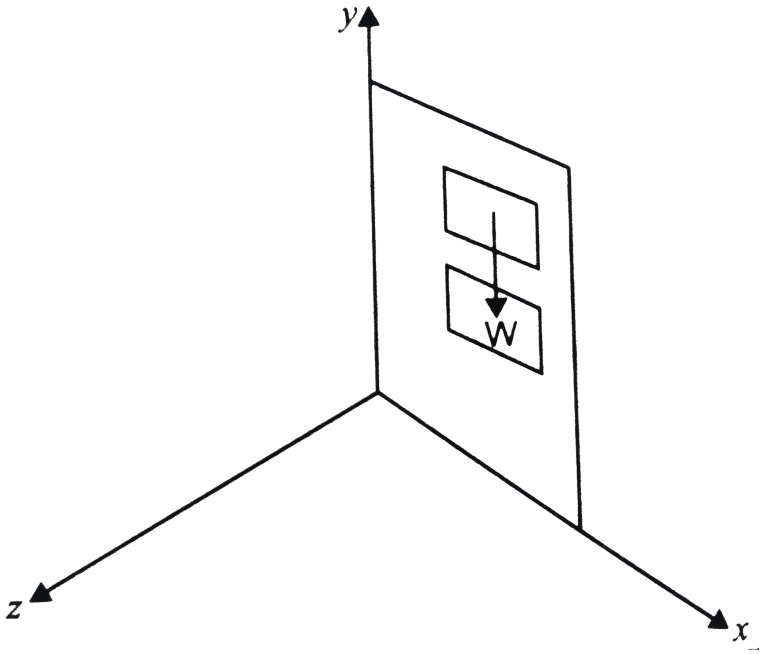

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9. $(n-1)$ equal point masses each of mass m are placed at the vertices of a angular n-

polygon. The vacant vertex has a position vector a with respect to the centre of the polygon. Find the position vector of centre of mass.

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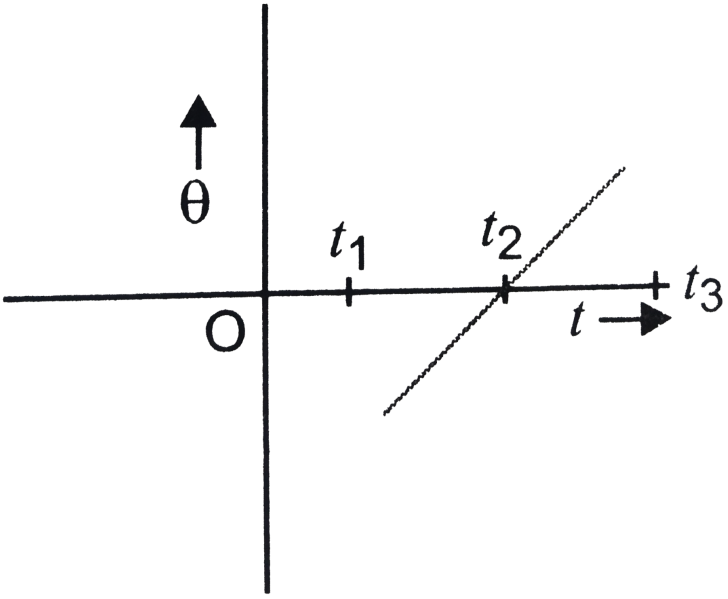

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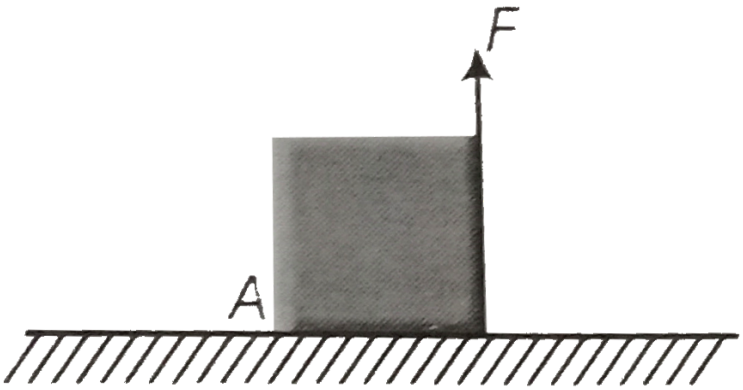

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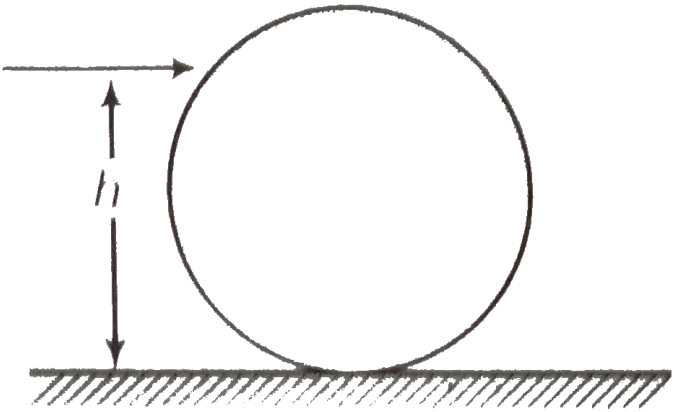

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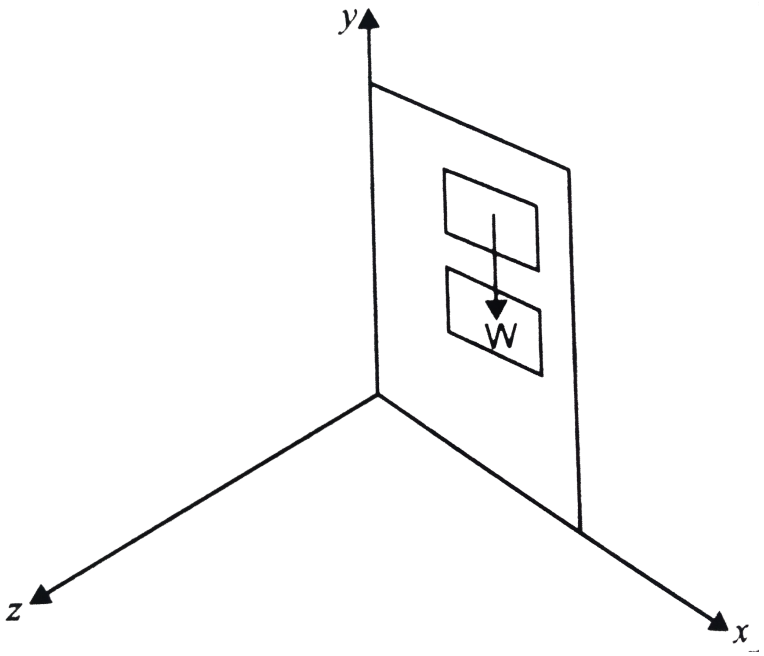

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Long Answer Type Questions

1. Find the centre of mass of a unifrom (a) half-disc,(b) quarter-disc.

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2. Two discs of moments of inertia I_1 and I_2 about their respective axes (normal to the disc and passing through the centre), and rotating with angular speed ω_1 and ω_2 are brought into contact face to face with their axes of rotation coincident . What is the angular speed of the two-disc system ?

A. Does the law of conservation of angular monentum apply to the situation ? Why ?

B. Find the angular speed of the two disc system .

C. Calculate the loss in kinetic energy of the system in the the process.

D. Account for this loss.

Answer:

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3. A disc of radius R is rotating with an angular speed ω_0 about a horizontal axis. It is placed on a horizontal table. The coefficient of kinetic friction is μ_k.

(a) What was the velocity of its centre of mass before being brought in contact with the table ?

(b) What happens to the linear velocity of a point on its rim when placed in contact with the table ?

(c) What happens to the linear speed of the centre of mass when disc is placed in contact

with the table ?

(d) Which force i sresponsible for the effects in (b) and (c).

(e) What condition should be satisfied for rolling to begin ?

(f) Calculate the time taken for the rolling to begin.

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4. Two cylindrical hollow drums of radii R and $2R$, and of a commom height h, are

rotating with angular velocities ω (anti-clockwise) and ω (clockwise), respectively. Their axes, fixed are parallel and in a horizontal plane separated by $(3R + \delta)$. They are now brought in contact $(\delta \to 0)$.

(a) Show the frictional forces just after contact.

(b) Identify forces and torque external to the system just after contact.

(c) What would be the ratio of final angular velocities when friction ceases ?

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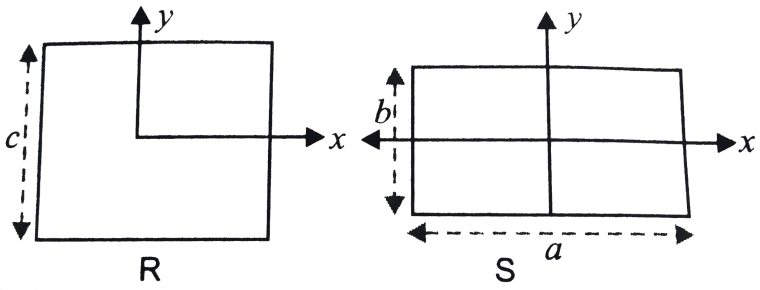
5. A uniform square plate $S(sidec)$ and a unifrom rectangular plate $R(sideb, a)$ have identical areas and mass [Fig.]

Show that

(i) $I_{xR}/I_{xS} < 1$, (ii) $I_{yR}/I_{yS} > 1$, (iii) $I_{zR}/I_{zS} > 1$.



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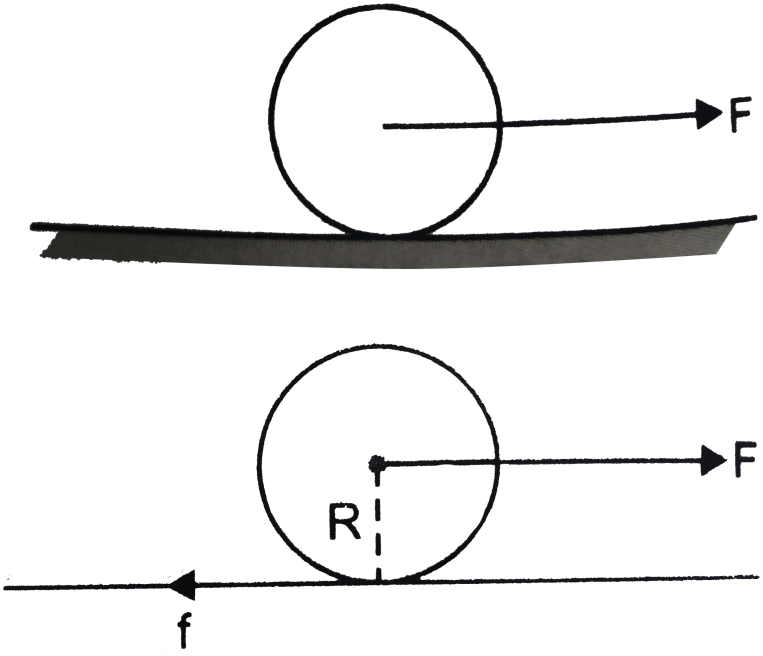
6. A unifrom disc of radius R, is resting on a table on its rim. The coefficient of friction between disc and table is μ Fig. Now the disc is pulled with a force F as shown in the Fig. What is the maximum value of F for which the disc rolls without slipping ?



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7. Find the centre of mass of a uniform :

(a) half-disc, (b) quarter-disc.

A. $\left(\frac{4R}{3\pi}, \frac{3R}{3\pi}\right), \left(\frac{4R}{3\pi}, \frac{3R}{3\pi}\right)$

B. $\left(0, \frac{4R}{3\pi}\right), \left(\frac{4R}{3\pi}, \frac{3R}{3\pi}\right)$

C. $\left(0, \frac{4R}{3\pi}\right), \left(\frac{4R}{3\pi}, \frac{4R}{3\pi}\right)$

D. $\left(\frac{2R}{2\pi}, \frac{4R}{3\pi}\right), \left(\frac{4R}{3\pi}, \frac{4R}{3\pi}\right)$

Answer: C

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8. Two discs of moments of inertia I_1 and I_2 about their respective axes (normal to the disc and passing through the centre), and rotating with angular speeds ω_1 and ω_2 are brought into contact face to face with their axes of rotation coincident. (a) What is the angular speed of the two-disc system? (b) Show that the kinetic energy of the combined system is less than the sum of the initial kinetic energies

of the two discs. How do you account for this loss in energy? Take $\omega_1 \neq \omega_2$

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9. A disc of radius R is rotating with an angular speed ω_0 about a horizontal axis. It is placed on a horizontal table. The coefficient of kinetic friction is μ_k.

(a) What was the velocity of its centre of mass before being brought in contact with the table ?

(b) What happens to the linear velocity of a

point on its rim when placed in contact with the table ?

(c) What happens to the linear speed of the centre of mass when disc is placed in contact with the table ?

(d) Which force i sresponsible for the effects in (b) and (c).

(e) What condition should be satisfied for rolling to begin ?

(f) Calculate the time taken for the rolling to begin.

A. $t = \frac{(R\omega_0)^2}{\mu_k g\left(1 + \frac{mR^2}{I}\right)}$

B. $t = \dfrac{R\omega_0}{\mu_k g\left(1 + \frac{mR^2}{I}\right)}$

C. $t = \dfrac{R\omega_0}{\mu_k g\left(1 + \frac{mR^2}{I}\right)^{\frac{1}{2}}}$

D. $t = \dfrac{R\omega_0}{\mu_k g\left(1 + \frac{R^2}{I}\right)}$

Answer: B

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10. Two cylindrical hollow drums of radii R and $2R$, and of a commom height h, are rotating with angular velocities ω (anti-

clockwise) and ω (clockwise), respectively. Their axes, fixed are parallel and in a horizontal plane separated by $(3R + \delta)$. They are now brought in contact $(\delta \to 0)$.

(a) Show the frictional forces just after contact.

(b) Identify forces and torque external to the system just after contact.

(c) What would be the ratio of final angular velocities when friction ceases ?

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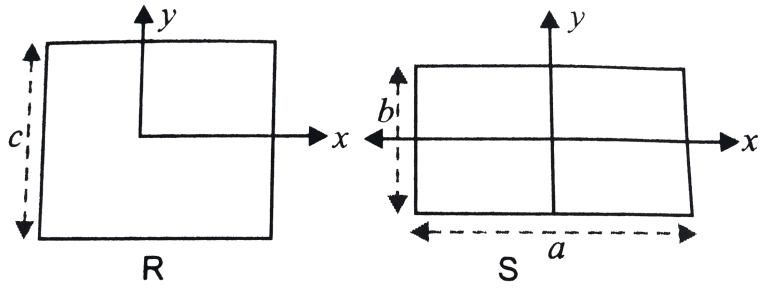
11. A uniform square plate $S(sidec)$ and a unifrom rectangular plate $R(sideb, a)$ have identical areas and mass [Fig.]

Show that

(i) $I_{xR}/I_{xS} < 1$, (ii) $I_{yR}/I_{yS} > 1$, (iii) $I_{zR}/I_{zS} > 1$.



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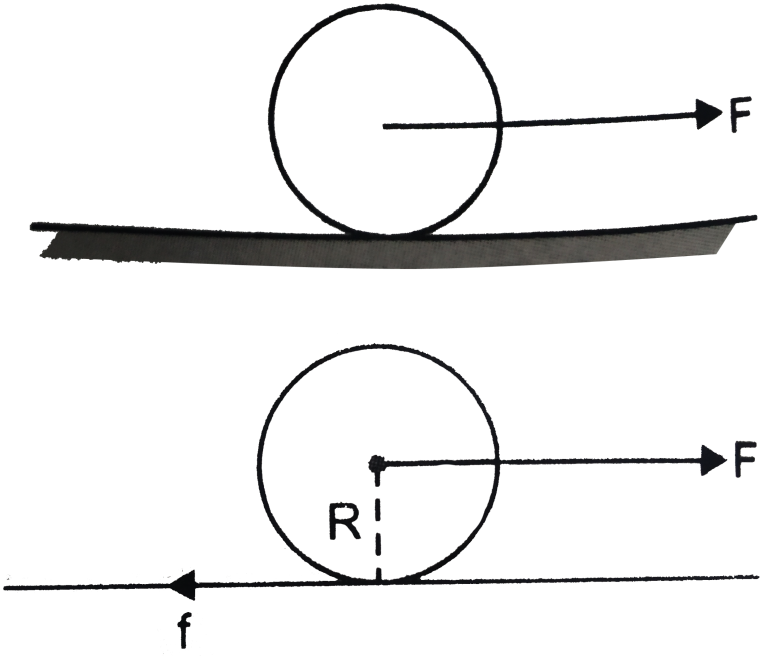
12. A unifrom disc of radius R, is resting on a table on its rim. The coefficient of friction between disc and table is μ Fig. Now the disc is pulled with a force F as shown in the Fig. What is the maximum value of F for which the disc rolls without slipping ?



A. $F_{\max} = 3\mu Mg$

B. $F_{\max} = 2\mu Mg$

C. $F_{\max} = \left(\frac{1}{2}\right)\mu Mg$

D. $F_{\max} = 4\mu Mg$

Answer: A

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