PHYSICS

DPP

DAILY PRACTICE PROBLEMS

# DPP No. 58

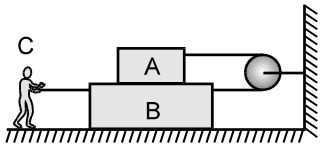
**Total Marks : 31**

**Max. Time : 35 min.**

**Topics : Friction, Center of Mass, Rigid Body Dynamics, Rotation**

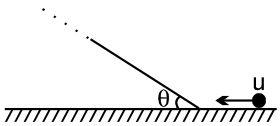
| Type of Questions | | M.M., Min. |
|---|---|---|
| Single choice Objective ('–1' negative marking) Q .1 to Q.4 | (3 marks, 3 min.) | [12, 12] |
| Subjective Questions ('–1' negative marking) Q.5 to Q.8 | (4 marks, 5 min.) | [16, 20] |
| Assertion and Reason (no negative marking) Q. 9 | (3 marks, 3 min.) | [3 , 3] |

**1.** In the figure $m_A = m_B = m_C = 60$ kg. The co-efficient of friction between C and ground is 0.5, B and ground is 0.3, A & B is 0.4. C is pulling the string with the maximum possible force without moving. Then tension in the string connected to A will be:



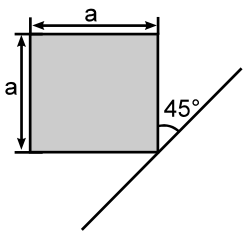

(A) 120 N
(B) 60 N
(C) 100 N
(D) zero

**2.** A particle of mass m is given initial speed u as shown in the figure. It move to the fixed inclined plane without a jump, that is, its trajectory changes sharply from the horizontal line to the inclined line. All the surfaces are smooth and $90° \geq \theta > 0°$. Then the height to which the particle shall rise on the inclined plane (assume the length of the inclined plane to be very large)




(A) increases with increase in $\theta$
(B) decreaseswith increase in $\theta$
(C) is independent of $\theta$
(D) data insufficient

**3.** The moment of inertia of a thin sheet of mass M of the given shape about the specified axis is (axis and sheet both are in same plane:)



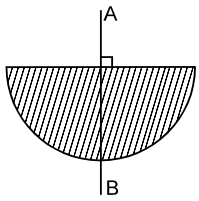

(A) $\frac{7}{12}$ $Ma^2$
(B) $\frac{5}{12}$ $Ma^2$
(C) $\frac{1}{3}$ $Ma^2$
(D) $\frac{1}{12}$ $Ma^2$

**4.** A man stands at one end of a boat which is stationary in water. Neglect water resistance. The man now moves to the other end of the boat and again becomes stationary. The centre of mass of the 'man plus boat' system will remain stationary with respect to water.

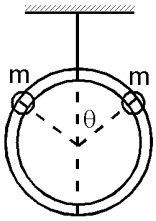
(A) in all cases
(B) only when the man is stationary initially and finally
(C) only if the man moves without acceleration on the boat
(D) only if the man and the boat have equal masses.

**5.** A uniform semicircular disc of mass 'm' and radius 'R' is shown in the figure. Find out its moment of inertia about

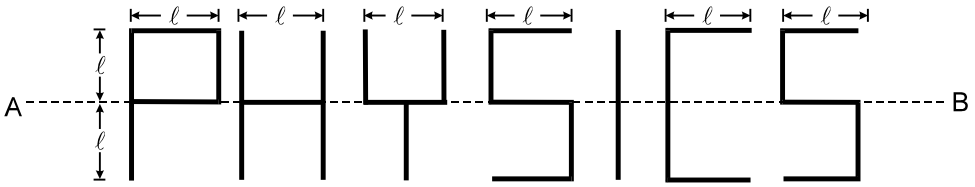
(a) axis 'AB' (shown in the figure) which passes through geometrical centre and lies in the plane of the disc
(b) axis 'CD' which passes through its centre of mass and it is perpendicular to the plane of the disc.



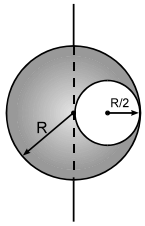

**6.** A massless ring hangs from a thread and two beads of mass m slide on it without friction. The beads are released simultaneously from the top of the ring and slide down along opposite sides. Find the angle from vertical at which the ring will start to rise.




**7.** Find out the moment of inertia of the following structure (written as PHYSICS) about axis AB made of thin uniform rods of mass per unit length λ.




**8.** A spherical cavity is formed from a solid sphere by removing mass from it. The resultant configuration is shown in figure. Find out the moment of inertia of this configuration about the axis through centre of the solid sphere as shown. Take mass M (uniform) for the configuration and radius R for solid sphere and radius R/2 for cavity.




**9.** **STATEMENT-1 :** Two spheres undergo a perfectly elastic collision. The kinetic energy of system of both spheres is always constant. [There is no external force on system of both spheres].

**STATEMENT-2 :** If net external force on a system is zero, the velocity of centre of mass remains constant.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

# Answers Key

## DPP NO. - 58

**1.** (D) **2.** (B) **3.** (A) **4.** (A)

**5.** (a) $I_{AB} = \frac{1}{4}mR^2$

(b) $I_{CD} = \frac{1}{2}mR^2 - m\left(\frac{4R}{3\pi}\right)^2$ by parallel axis Theorem

**6.** $\cos^{-1}\left(\frac{2}{3}\right)$ **7.** $13\,\lambda\ell^3$ **Ans.**

**8.** $I = \frac{57}{140}MR^2$ **9.** (D)

# Hint & Solutions

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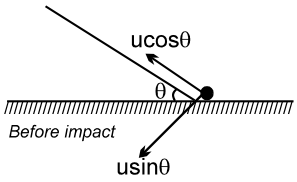
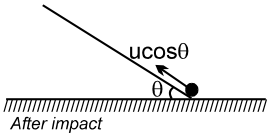
**1.** Maximum frictional force between C and ground
= 300 Nt
Max. frictional force between B and ground
= 360 Nt
So man is unable to pull B Hence T = 0

**2.** Just before the particle transfers to inclined surface, we resolve its velocity along and normal to the plane.

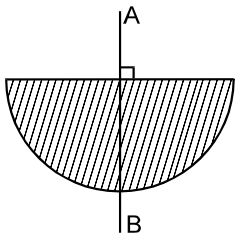



For the trajectory of the particle to sharply change from the horizontal line to the inclined line, the impact of the particle with inclined plane should reduce the usinθ component of velocity to zero. Hence the particle moves up the incline with speed u cosθ.
Hence as θ increases, the height to which the particle rises shall decrease.

**4.** $F_{ext}$ on system (man + boat) is zero and initially COM is at rest so that COM of system always remains at rest.

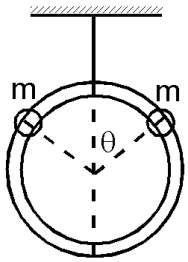
**5.**



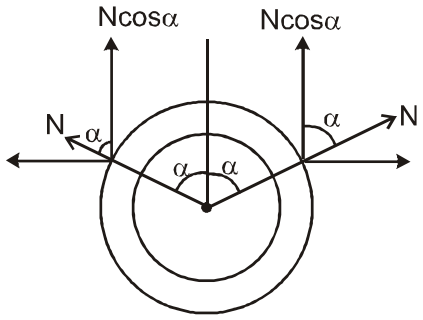

(a) $I_{AB} = \frac{1}{4}mR^2$ ....Ans. (b) $I_{CD} = \frac{1}{2}mR^2 - m\left(\frac{4R}{3\pi}\right)^2$

by parallel axis Theorem ....Ans.

**6.**




at $\alpha = \cos^{-1}\left(\frac{2}{3}\right)$ balls will leave contact with inner wall and came in contact with outer wall then force on ring will be $2N\cos\alpha$ in upward direction.




So ring will start rising as it is massless

**7.** The moment of inertia of all seven rods parallel to AB and not lying on AB is

$= 7 \times (\lambda\ell)\ \ell^2 = 7\ \lambda\ \ell^3$

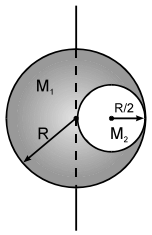
the moment of inertia of all five rods lying on AB = 0

The moment of inertia of all 18 rods perpendicular to AB is $= 18\ (\lambda\ell)\ \frac{\ell^2}{3} = 6\ \lambda\ell^3$

Hence net MI of rod about AB

$= 7\ \lambda\ell^3 + 6\ \lambda\ell^3 = \mathbf{13\ \lambda\ell^3}$ **Ans.**

**8.**




$$\rho = \frac{M}{(4/3)\pi R^3 - (4/3)\pi(R/2)^3}$$

$$I = \frac{2}{5}MR^2 - \left(\frac{2}{5}M_2\left(\frac{R}{2}\right)^2 + M_2\left(\frac{R}{2}\right)^2\right)$$

$$; I = \frac{57}{140}MR^2$$

**9.** During colision KE of system is not constant, hence statement-1 is false.