PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 48

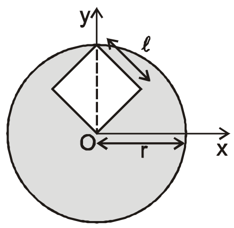
Total Marks : 25

Max. Time : 26 min.

Topics : Center of Mass, Circular Motion, Work, Power and Energy, Friction

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Subjective Questions ('–1' negative marking) Q.4	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]
Assertion and Reason (no negative marking) Q. 8	(3 marks, 3 min.)	[3, 3]

1. A disc (of radius r cm) of uniform thickness and uniform density ρ has a square hole with sides of length $\ell = \sqrt{\ }$ cm. One corner of the hole is located at the center of the disc and centre of the hole lies on y-axis as shown. Then the y-coordinate of position of center of mass of disc with hole (in cm) is

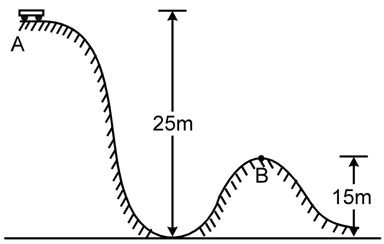


(A) $-\frac{r}{2(\pi-\frac{1}{4})}$ (B) $-\frac{r}{4(\pi-\frac{1}{4})}$ (C) $-\frac{r}{4(\pi-\frac{1}{2})}$ (D) $-\frac{3r}{4(\pi-\frac{1}{4})}$

2. A flywheel rotates with a uniform angular acceleration. Its angular velocity increases from 20π rad/s to 40π rad/s in 10 seconds. How many rotations did it make in this period?

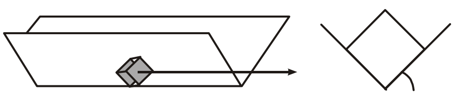
(A) 80 (B) 100 (C) 120 (D) 150

3. Figure shows the roller coaster track. Each car will start from rest at point A and will roll with negligible friction. It is important that there should be at least some small positive normal force exerted by the track on the car at all points, otherwise the car would leave the track. With the above fact, the minimum safe value for the radius of curvature at point B is ($g = 10\ m/s^2$) :



(A) 20 m (B) 10 m (C) 40 m (D) 25 m

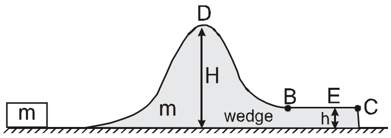
4. A crate of mass m is pulled with a force F along a fixed right angled horizontal trough as in figure. The coefficient of kinetic friction between the crate and the trough is μ. Find the value of force F required to pull it along the trough with constant velocity.



COMPREHENSION

Figure shows an irregular wedge of mass m placed on a smooth horizontal surface. Part BC is rough.

5. What minimum velocity should be imparted to a small block of same mass m so that it may reach point B :



(A) $2\sqrt{gH}$ (B) $\sqrt{2gH}$ (C) $2\sqrt{g(H-h)}$ (D) $\sqrt{gh}$

6. The magnitude of velocity of wedge when the block comes to rest (w.r.t. wedge) on part BC is :

(A) $\sqrt{gH}$ (B) $\sqrt{g(H-h}$ (C) $2\sqrt{gH}$ (D) none of these

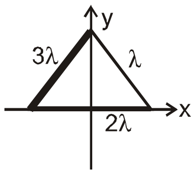
7. If the coefficient of friction between the block and wedge is μ, and the block comes to rest with respect to wedge at a point E on the rough surface then BE will be

(A) $\frac{H}{\mu}$ (B) $\frac{H-h}{\mu}$ (C) $\frac{h}{\mu}$ (D) none of these

8. In each situation of column-I a mass distribution is given and information regarding x and y-coordinate of centre of mass is given in column-II. Match the figures in column-I with corresponding information of centre of mass in column-II.

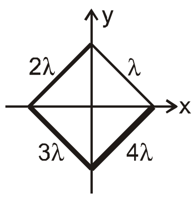
Column-I **Column-II**

(A) An equilateral triangular wire frame is made using three thin uniform rods of mass per unit lengths λ, 2λ and 3λ as shown



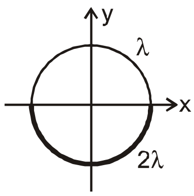
(p) $x_{cm} \geq 0$

(B) A square frame is made using four thin uniform rods of mass per unit length lengths λ, 2λ, 3λ and 4λ as shown



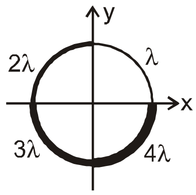
(q) $y_{cm} \geq 0$

(C) A circular wire frame is made of two uniform semicircular wires of same radius and of mass per unit length λ and 2λ as shown



(r) $x_{cm} < 0$

(D) A circular wire frame is made of four uniform quarter circular wires of same radius and mass per unit length λ, 2λ, 3λ and 4λ as shown



(s) $y_{cm} < 0$

Answers Key

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1.	(C)	**2.**	(D)	**3.**	(A)
4.	$F = \sqrt{2}\mu mg$	**5.**	(A)	**6.**	(A)
7.	(B)	**8.**	(A) q,r (B) p,s (C) p,s (D) p,s		

Hint & Solutions

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1. This disc can be assumed to be made of a complete uniform disc and a square plate with same negative mass density.

$$Y_{cm} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2}$$

$$= \frac{(\pi r^2)\sigma(0) + \ell^2(-\sigma)(r/2)}{\pi r^2\sigma + \ell^2(-\sigma)}$$

$$= \frac{-\ell^2 r}{2(\pi r^2 - \ell^2)} = \frac{-\frac{r^3}{2}}{2(\pi r^2 - \frac{r^2}{2})} = \frac{-r}{4\left(\pi - \frac{1}{2}\right)}$$

2. $\alpha = \dfrac{40\pi - 20\pi}{10}$ rad/sec^2

$= 2\pi$ rad/sec^2

$\omega_2^2 = \omega_1^2 + 2\alpha\theta$

$(40\pi)^2 = (20\pi)^2 + 2(2\pi)\theta$

$$\theta = \frac{(40\pi)^2 - (20\pi)^2}{4\pi} = \frac{60\pi \times 20\pi}{4\pi} = 300\pi$$

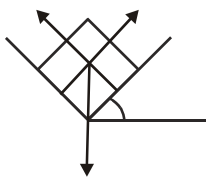
$2\pi n = 300\pi$

$n = 150.$

3. $V_B = \sqrt{2\times10\times10}$; $m v_B \underline{<} mg$; $R \underline{>} v_B$

$\Rightarrow R \underline{>} 20$ m

4. $2N \sin 45^\circ = mg$



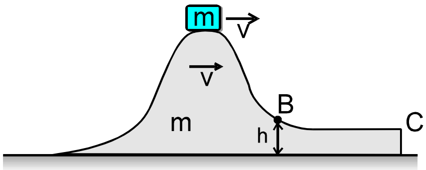
$N = \dfrac{mg}{\sqrt{2}}$

$F = 2\mu N$

$= 2\mu \dfrac{mg}{\sqrt{2}} = \sqrt{2}\,\mu mg.$

5. Let 'u' be the required minimum velocity. By momentum conservation :

$mu = (m + m)v \Rightarrow v = u/2.$



(At highest point)

Energy equation :

$$\frac{1}{2}mu^2 = \frac{1}{2}(2m)v^2 + mgH.$$

Substituting v = u/2 :

$u = 2\sqrt{gH}$

6. When the block comes to rest, the wedge continues to move at $V = \frac{u}{2} = \sqrt{gH}$ on the smooth surface.

(since, momentum of wedge-block system remains conserved).

7. By work-energy theorem on the system :

$-(\mu mg)(BE) - mgh = -\frac{}{}\,mu^2$

$= -\frac{}{}m(4gH) \Rightarrow BE = \frac{}{}$

8. (A) Centre of mass lies in second quadrant.

(B), (C) and (D) Centre of mass lies on y-axis and below x-axis.