PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 51

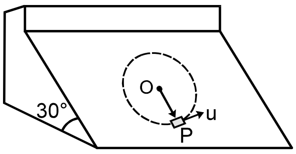
Total Marks : 30

Max. Time : 33 min.

Topics : Circular Motion, Center of Mass

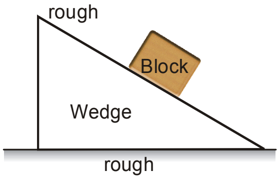
Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.6	**(3 marks, 3 min.)**	**[18, 18]**
Subjective Questions ('–1' negative marking) Q.7	**(4 marks, 5 min.)**	**[4, 5]**
Match the Following (no negative marking) (2 × 4)Q.8	**(8 marks, 10 min.)**	**[8, 10]**

1. A particle is attached with a string of length ℓ which is fixed at point O on an inclined plane what minimum velocity should be given to the particle along the incline so that it may complete a circle on inclined plane (plane is smooth and initially particle was resting on the inclined plane.)



(A) $\sqrt{5g\ell}$ (B) $\sqrt{\frac{5g\ell}{2}}$ (C) $\sqrt{\frac{5\sqrt{3}g\ell}{2}}$ (D) $\sqrt{4g\ell}$

2. When a block is placed on a wedge as shown in figure, the block starts sliding down and the wedge also start sliding on ground. All surfaces are rough. The centre of mass of (wedge + block) system will move

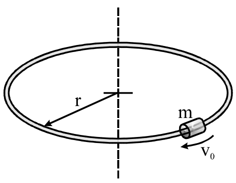


(A) leftward and downward. (B) right ward and downward.
(C) leftward and upwards. (D) only downward.

3. A shell of mass 4 kg moving with a velocity 10 m/s vertically upward explodes into three parts at a height 50 m from ground. After three seconds, one part of mass 2 kg reaches ground and another part of mass 1 kg is at height 40 m from ground. The height of the third part from the ground is: [g = 10 m/s^2]

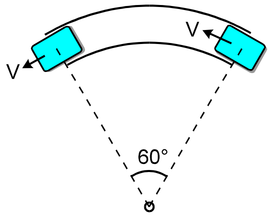
(A) 50 m (B) 80 m (C) 100 m (D) none of these

4 A small hoop of mass m is given an initial velocity of magnitude v_0 on the horizontal circular ring of radius 'r'. If the coefficient of kinetic friction is μ_k the tangential acceleration of the hoop immediately after its release is (assume the horizontal ring to be fixed and not in contact with any supporting surface)



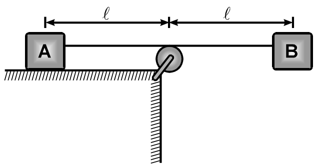
(A) $\mu_k g$ (B) $\mu_k \frac{v_0^2}{r}$ (C) $\mu_k \sqrt{g^2 + \frac{v_0^2}{r}}$ (D) $\mu_k \sqrt{g^2 + \frac{v_0^4}{r^2}}$

5. A car moves around a curve at a constant speed. When the car goes around the arc subtending 60° at the centre, then the ratio of magnitude of instantaneous acceleration to average acceleration over the 60° arc is :



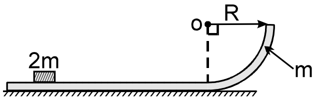
(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{6}$ (C) $\frac{2\pi}{3}$ (D) $\frac{5\pi}{3}$

6. Two blocks A and B each of same mass are attached by a thin inextensible string through an ideal pulley. Initially block B is held in position as shown in figure. Now the block B is released. Bolck A will slide to right and hit the pulley in time t_A. Block B will swing and hit the surface in time t_B. Assume the surface as frictionless.



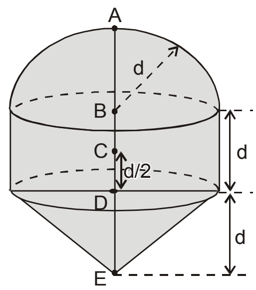
(A) $t_A = t_B$
(B) $t_A < t_B$
(C) $t_A > t_B$
(D) data are not sufficient to get relationship between t_A and t_B.

7. Mass 2m is kept on a smooth circular track of mass m which is kept on a smooth horizontal surface. The circular track is given a horizontal velocity $\sqrt{2gR}$ towards left. Find the maximum height reached by 2m.



8. **Match the following**

Following is a solid object formed by three parts which are a solid hemisphere, solid cyllinder and a solid cone. The material of the object is uniform and all the above parts are made up of the same material. The dimensions of the objects are indicated in the figure. The points A,B,C,D,E lie on the common axis of the system as shown in the figure. Point C is the centre of the cylinder.



Column I	**Column II**
(A) Centre of mass of the whole system lies on segment	(p) AB
(B) Centre of mass of the system of only hemisphere and cyllinder lies on segment	(q) BC
(C) Centre of mass of the system of only cone and cyllinder lies on segment	(r) CD
(D) Centre of mass of the system of only hemisphere and cone lies on segment	(s) DE

Answers Key

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

Hint & Solutions

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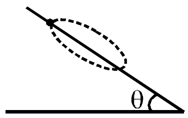
1. The side view of circular motion is as shown :



$T + mg \sin\theta = \frac{mv^2}{R}$

and by energy conservation :

$\frac{1}{2} mv_i^2 = \frac{1}{2} mv^2 + mg2R(\sin\theta)$

for v_i to be minimum, v is minimum and hence
T = 0

$\Rightarrow \quad v_i^2 = 5gR. \sin\theta$

$\Rightarrow \quad v_i)_{min} = \sqrt{\frac{5g\ell}{2}}$ **Ans.**

2. Friction force between wedge and block is internal i.e. will not change motion of COM. Friction force on the wedge by ground is external and causes COM to move towards right. Gravitational force (mg) on block brings it downward hence COM comes down.

3. After 3 sec. height of COM. is $50 + ut - \frac{1}{2} gt^2$

$= 50 + 10 \times 3 - \frac{1}{2} \times 10 \times 3^2$

= 35 m

$H_{C.M.} = \frac{m_1H_1 + m_2H_2 + m_3H_3}{m_1 + m_2 + m_3}$

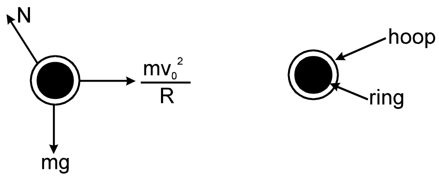
$35 = \frac{2 \times 0 + 1 \times 40 + 1 \times H_3}{4}$

H = 100 m

4 The free body daigram of hoop is

$\therefore$ The normal reaction $N = \sqrt{m^2g^2 + \frac{m^2{v_0}^4}{r^2}}$

$\therefore$ Frictional force $= \mu_k N = \mu_k \sqrt{m^2g^2 + \frac{m^2{v_0}^4}{r^2}}$



$\therefore$ tangential acceleration $= \frac{\mu_k N}{m}$

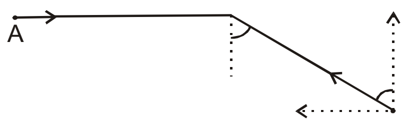
$= \mu_k \sqrt{g^2 + \frac{{v_0}^4}{r^2}}$

5. $\left|\Delta\vec{V}\right| = \sqrt{v^2 + v^2 - 2v^2 \cos 60^\circ} \quad = v$

$\vec{a}_{avg} = \frac{|\Delta v|}{\Delta t} = \frac{v}{t} = \frac{3v^2}{\pi R} \Rightarrow a_i = \frac{v^2}{R}$; $\frac{a}{a}$

$= \frac{v^2 \pi R}{R \times 3v^2} = \frac{\pi}{3}$

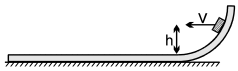
6.



T sin θ < T

$\therefore$ $t_A < t_B$

7. Let v be the final speed of block when it is at maximum height h. At that instant the speed of circular track shall also be v.



From conservation of momentum

$$m\sqrt{2gR} = (m + 2m)\,v \qquad ....(1)$$

From conservation of energy

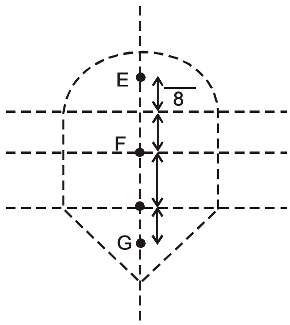
$$\frac{1}{2}m\,(2gR) = \frac{1}{2}(m + 2m)\,v^2 + 2mgh \,....(2)$$

solving (1) and (2) we get

$2h = \frac{2}{3}R$ **Ans. R/3**

8. Replacing the three bodies by their Com at E, F & G. Let ρ be their common density.

$$X_{cm} = \frac{\left[\rho\left(\frac{1}{3}\pi d^3\right)\right]\left[\frac{-d}{4}\right] + \rho(\pi d^3)\left[\frac{d}{2}\right] + \left[\rho\left(\frac{2}{3}\pi d^3\right)\right]\left[\frac{11}{8}d\right]}{\rho\left(\frac{1}{3}\pi d^3\right) + \rho(\pi d^3) + \rho\left(\frac{2}{3}\pi d^3\right)}$$



where, $\rho\left(\frac{1}{3}\pi d^3\right)$ is the mass of cone,

$\rho(\pi d^3)$ is the mass of cylinder

& $\rho\left(\frac{2}{3}\pi d^3\right)$ is the mass of hemisphere.