PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 44

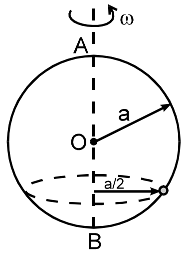
Total Marks : 36

Max. Time : 38 min.

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

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[15, 15]
Multiple choice objective ('–1' negative marking) Q.5	(4 marks, 4 min.)	[4, 4]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q. 9	(8 marks, 10 min.)	[8, 10]

1. A smooth wire is bent into a vertical circle of radius ***a***. A bead P can slide smoothly on the wire. The circle is rotated about vertical diameter AB as axis with a constant speed ω as shown in figure. The bead P is at rest w.r.t. the wire in the position shown. Then ω^2 is equal to :



(A) $\frac{2g}{a}$ (B) $\frac{2g}{a\sqrt{3}}$ (C) $\frac{g\sqrt{3}}{a}$ (D) $\frac{2a}{g\sqrt{3}}$

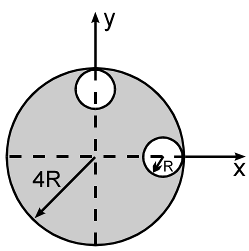
2. A ball suspended by a thread swings in a vertical plane so that its acceleration in the extreme position and lowest position are equal in magnitude. Angle θ of thread deflection in the extreme position will be:

(A) $2\tan^{-1}\frac{1}{2}$ (B) $\tan^{-1}\frac{1}{2}$ (C) $\tan^{-1}\sqrt{2}$ (D) $\tan^{-1} 2$

3. An automobile enters a turn of radius R. If the road is banked at an angle of 45^0 and the coefficient of friction is 1, the minimum and maximum speed with which the automobile can negotiate the turn without skidding is:

(A) $\sqrt{\frac{rg}{2}}$ and $\sqrt{rg}$ (B) $\frac{\sqrt{rg}}{2}$ and $\sqrt{rg}$ (C) $\frac{\sqrt{rg}}{2}$ and $2\sqrt{rg}$ (D) 0 and infinite

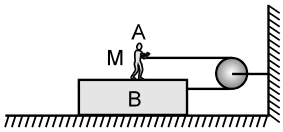
4. From the uniform disc of radius 4 R two small disc of radius R are cut off. The centre of mass of the new structure will be : (Centre of lower circular cavity lies on x-axis and centre of upper circular cavity lies on y-axis)



(A) $\hat{i}\frac{R}{5}+\hat{j}\frac{R}{5}$ (B) $-\hat{i}\frac{R}{5}+\hat{j}\frac{R}{5}$

(C) $-\hat{i}\frac{R}{5}-\hat{j}\frac{R}{5}$ (D) $-\frac{3R}{14}(\hat{i}+\hat{j})$

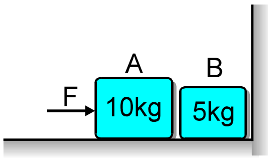
5. As shown in the figure, M is a man of mass 60 kg standing on a block of mass 40 kg kept on ground. The co-efficient of friction between the feet of the man and the block is 0.3 and that between B and the ground is 0.1. If the person pulls the string with 100 N force, then :



(A) B will slide on ground
(B) A and B will move together with acceleration 1 m/s^2
(C) the friction force acting between A & B will be 40 N
(D) the friction force acting between A & B will be 180 N

COMPREHENSION

Two bodies A and B of masses 10 kg and 5 kg are placed very slightly separated as shown in figure. The coefficient of friction between the floor and the blocks is $\mu = 0.4$. Block A is pushed by an external force F. The value of F can be changed. When the welding between block A and ground breaks, block A will start pressing block B and when welding of B also breaks, block B will start pressing the vertical wall –

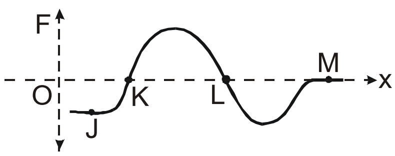


6. If F = 20 N, with how much force does block A presses the block B
(A) 10 N (B) 20 N (C) 30 N (D) Zero

7. What should be the minimum value of F, so that block B can press the vertical wall
(A) 20 N (B) 40 N (C) 60 N (D) 80 N

8. If F = 50 N, the friction force (shear force) acting between block B and ground will be :
(A) 10 N (B) 20 N (C) 30 N (D) None

9. A particle moving along x-axis is being acted upon by one dimensional conservative force F. In the F–x curve shown, four points J, K, L, M are marked on the curve. Column II gives different type of equilibrium for the particle at different positions. Column I gives certain positions on the force position graphs. Match the positions in Column-I with the corresponding nature of equilibrium at these positions.



Column I	Column II
(A) Point J is position of	(p) Neutral equilibrium
(B) Point K is position of	(q) Unstable equilibrium
(C) Point L is position of	(r) Stable equilibrium
(D) Point M is position of	(s) No equilibrium

Answers Key

DPP NO. - 44

1. (B) **2.** (A) **3.** (D)
4. (D) **5.** (A) (B) (C)
6. (D) **7.** (C) **8.** (A)
9. (A) s (B) q (C) r (D) p

Hint & Solutions

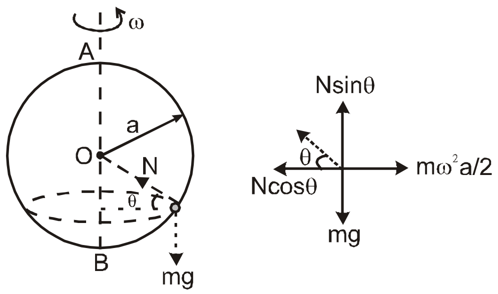
DPP NO. - 44

1. As ; $\cos\theta = \frac{a}{2a}$

$\theta = 60^\circ$

$\therefore$ $N \sin 60^\circ = mg$

$N \cos 60^\circ = m \frac{\omega^2 a}{2}$

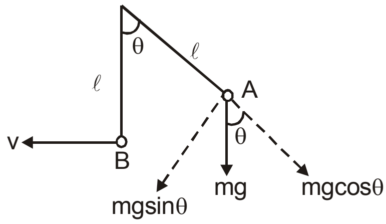


w.r.t. wire

$\therefore$ $\tan 60^\circ = \frac{2g}{\omega^2 a}$ $\qquad \omega^2 = \frac{2g}{a\sqrt{3}}$

2. $a_A = g \sin\theta$ (only tangential)

$a_B = \frac{v^2}{\ell}$ (only radial)



K.E. + P.E. = K.E. + P.E.

$$= \frac{1}{2}m0^2 + mg\ell(1-\cos\theta) = \frac{1}{2}mv^2$$

$v^2 = 2g\ell\,(1 - \cos\theta)$ ....(i)

$$\therefore \quad a_B = \frac{v^2}{\ell} = 2g(1 - \cos\theta)$$

Since, $a_A = a_B$

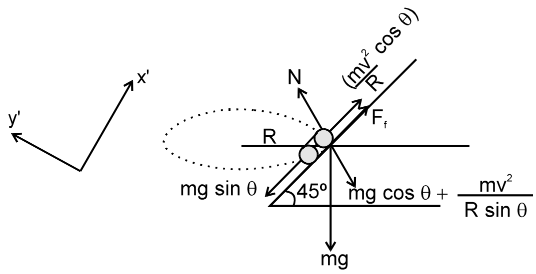
$\therefore \quad g\sin\theta = 2g(1 - \cos\theta)$

$$\Rightarrow \quad 2\sin\frac{\theta}{2}\cos\frac{\theta}{2} = 2 \times 2\sin^2\frac{\theta}{2}$$

$$\Rightarrow \quad \tan\frac{\theta}{2} = \frac{1}{2}$$

$$\Rightarrow \quad \theta = 2\tan^{-1}\left(\frac{1}{2}\right)$$ **Ans.(A)**

3. F.B.D. for minimum speed (w.r.t. automobile):



$$\Sigma f_{y'} = N - mg\cos\theta - \frac{mv^2}{R}\sin\theta = 0.$$

$$\Sigma f_{x'} = \frac{mv^2}{R}\cos\theta + \mu N - mg\sin\theta = 0$$

$$\Rightarrow \quad \frac{mv^2}{R}\cos\theta + \mu\left(mg\cos\theta + \frac{mv^2}{R}\right.$$

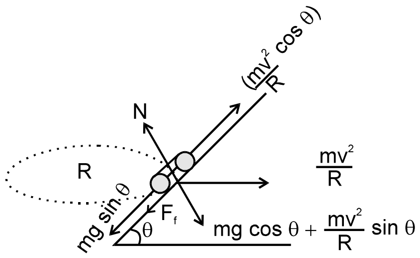
$$\left.\sin\theta\right) - mg\sin\theta = 0$$

$$\Rightarrow \quad v^2 = \frac{(\mu Rg\cos\theta - Rg\sin\theta)}{(\cos\theta + \mu\sin\theta)}$$

for $\theta = 45°$ and $\mu = 1$:

$$v_{min} = \frac{Rg - Rg}{1+1} = 0$$

F.B.D for maximum speed (w.r.t. automobile)



$$\Sigma f_{x'} = \frac{mv^2}{R}\cos\theta - mg\sin\theta - \mu\left(mg\cos\theta + \frac{mv^2}{R}\sin\theta\right) = 0$$

for $\theta = 45^\circ$ and $\mu = 1$

$v_{max} = \infty$ (infinite)

4. Centre of mass of circular disc of radius 4R = (0, 0)

Centre of mass of upper disc = (0, 3R)

Centre of mass of lower disc = (3R, 0)

Let M be mass of complete disc and then the mass of cut out disc are $\frac{M}{16}$

Hence, centre of mass of new structure is given by

$$\bar{x} = \frac{m_1x_1 - m_2x_2 - m_3x_3}{m_1 - m_2 - m_3}$$

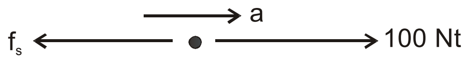
$$= \frac{M(0) - \frac{M}{16}(0) - \frac{M}{16}(3R)}{M - \frac{M}{16} - \frac{M}{16}} = \frac{-3R}{14}$$

$$\bar{y} = \frac{m_1y_1 - m_2y_2 - m_3y_3}{m_1 - m_2 - m_3}$$

$$= \frac{M(0) - \frac{M}{16}(3R) - \frac{M}{16}(0)}{M - \frac{M}{16} - \frac{M}{16}} = \frac{-3R}{14}$$

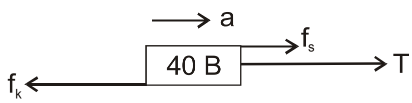
Position vector of C.M. $= -\frac{3R}{14}(\hat{i} + \hat{j})$

5. F BD of M



$100 - f_s = 60\,a \quad \rightarrow \quad (1)$

F BD of B



$T + f_s - f_k = 40\,a \quad \rightarrow \quad (2)$

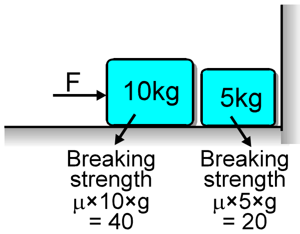
$f_k = (0.1)\,(60 + 40)\,g$

From (1) and (2)

$100 - f_s = 60\,a$

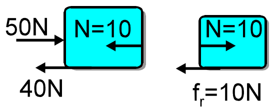
$f_s = 40$ Nt

6. If F = 20 N, 10 kg block will not move and it would not press 5 kg block So N = 0.



7. $F_{min} = f_A + f_B = 60$ N.

8. If F = 50 N, force on 5 kg block = 10 N



So friction force = 10 N

9. Point J ⟶ No equilibrium

K ⟶ Unstable equilibrium

L ⟶ Stable equilibrium

M ⟶ Neutral equilibrium