PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 75

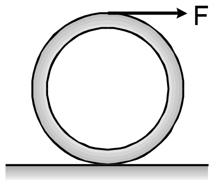
Total Marks : 24

Max. Time : 24 min.

Topic : Circular Motion, Center Of Mass, Rotation, Simple Harmonic Motion

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.5	**(3 marks, 3 min.)**	**[15, 15]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks, 3 min.)**	**[9, 9]**

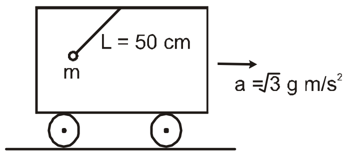
1. A ring of mass m and radius R rolls on a horizontal rough surface without slipping due to an applied force 'F'. The friction force acting on ring is : –



(A) $\frac{F}{3}$ (B) $\frac{2F}{3}$

(C) $\frac{F}{4}$ (D) Zero

2. A simple pendulum 50 cm long is suspended from the roof of a cart accelerating in the horizontal direction with constant acceleration $\sqrt{3}$ g m/s^2. The period of small oscillations of the pendulum about its equilibrium position is(g = π^2 m/s^2) :



(A) 1.0 sec (B) $\sqrt{2}$ sec

(C) 1.53 sec (D) 1.68 sec

3. If the length of a simple pendulum is doubled then the % change in the time period is :

(A) 50 (B) 41.4 (C) 25 (D) 100

4. A disc is hinged such that it can freely rotate in a vertical plane about a point on its radius. If radius of disc is 'R', then what will be minimum time period of its simple harmonic motion?

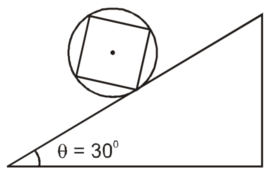
(A) $2\pi\sqrt{\frac{R}{g}}$ (B) $2\pi\sqrt{\frac{3R}{2g}}$ (C) $2\pi\sqrt{\frac{\sqrt{2}R}{g}}$ (D) $2\pi\sqrt{\frac{R}{2g}}$

5. A 25 kg uniform solid sphere with a 20 cm radius is suspended by a vertical wire such that the point of suspension is vertically above the centre of the sphere. A torque of 0.10 N-m is required to rotate the sphere through an angle of 1.0 rad and then maintain the orientation. If the sphere is then released, its time period of the oscillation will be :

(A) π second (B) $\sqrt{2}\pi$ second (C) 2π second (D) 4π second

COMPREHENSION

Four identical uniform rods of mass M = 6kg each are welded at their ends to form square and then welded to a uniform ring having mass m = 4kg & radius R = 1 m. The system is allowed to roll down the incline of inclination $\theta = 30^0$.



6. The moment of inertia of system about the axis of ring will be -

(A) 20 kg m^2 (B) 40 kg m^2 (C) 10 kg m^2 (D) 60 kg m^2.

7. The acceleration of centre of mass of system is -

(A) $\frac{g}{2}$ (B) $\frac{g}{4}$ (C) $\frac{7g}{24}$ (D) $\frac{g}{8}$

8. The minimum value of coefficient of friction to prevent slipping is -

(A) $\frac{5}{7}$ (B) $\frac{5}{12\sqrt{3}}$ (C) $\frac{5\sqrt{3}}{7}$ (D) $\frac{7}{5\sqrt{3}}$

Answers Key

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

Hint & Solutions

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1. **(D)** $F + f = ma$ .... (1)

Also ; $FR - fR = I\ \frac{a}{R}$

$F - f = ma$ .... (2)

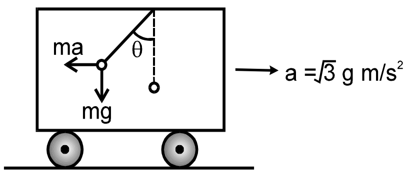
$[I = mR^2]$

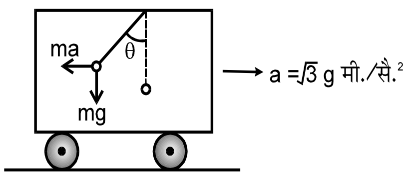
From (1) & (2)

$f = 0$.

2. With respect to the cart, equilibrium position of the pendulum is shown.

If displaced by small angle θ from this position, then it will execute SHM about this equilibrium position, time period of which is given by :





$T = 2\pi\sqrt{\frac{L}{g_{eff}}}$; $g_{eff} = \sqrt{g^2 + (\sqrt{3}g)^2}$

$\Rightarrow$ $g_{eff} = 2g$

$\Rightarrow$ $T = 1.0$ second

3. $\frac{\Delta T}{T} \times 100 = \frac{1}{2}\frac{\Delta \ell}{\ell} \times 100$ is not valid as $\Delta \ell$ is not small.

$$\frac{\Delta T}{T} \times 100 = \frac{1}{2}\frac{\Delta \ell}{\ell} \times 100$$

$T_1 = 2\pi\sqrt{\frac{\ell}{g}}$ $T_2 = 2\pi\sqrt{\frac{2\ell}{g}}$ % change

$$= \frac{T_2 - T_1}{T_1} \times 100 = (\sqrt{2} - 1) \times 100 = 41.4$$

4. For minimum time period

$$x = \frac{R}{\sqrt{2}}$$

$$\Rightarrow T = 2\pi\sqrt{\frac{\frac{mR^2}{2} + \frac{mR^2}{2}}{\frac{mgR}{\sqrt{2}}}} = 2\pi\sqrt{\frac{\sqrt{2}R}{g}}$$

5. (D) $\tau = -k\theta$

$0.1 = -k(1.0)$, where k is torsional constant of the wire.

$$k = \frac{1}{10}$$

$$T = 2\pi\sqrt{\frac{I}{k}} = 2\pi\sqrt{\frac{\frac{2}{5} \times 25 \times (.2)^2}{1/10}}$$

$= 2\pi\sqrt{10 \times .2 \times .2 \times 10}$ $= 4\pi$ second **Ans.**

6. to 8

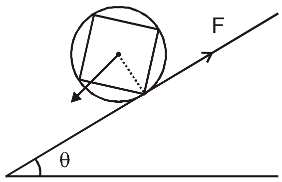
8. (**3 to 5**)

$$I = \left[\frac{M\left(R\sqrt{2}\right)^2}{12} + M\left(\frac{R}{\sqrt{2}}\right)^2\right] \times 4 + mR^2$$

= 20 kgm^2.

(4M + m)g sin θ – F = (4M + m)a.

$$F.R. = I\left(\frac{a}{R}\right)$$



Solving

$$a = \frac{7g}{24}$$

F = 20a $\leq$ μ (4M + m)g cos 30

$$\mu \geq \frac{5}{12\sqrt{3}}$$

$$\therefore \quad \mu_{min} = \frac{5}{12\sqrt{3}}$$