PHYSICS
DPP
DAILY PRACTICE PROBLEMS

DPP No. 42

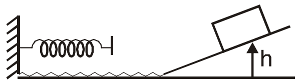
Total Marks : 22

Max. Time : 23 min.

Topics : Work, Power and Energy, Circular Motion

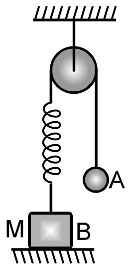
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Subjective Questions ('–1' negative marking) Q.7	(4 marks, 5 min.)	[4, 5]

1. A block of mass m starts at rest at height h on a frictionless inclined plane. The block slides down the plane, travels across a rough horizontal surface with coefficient of kinetic friction μ, and compresses a spring with force constant k a distance x before momentarily coming to rest. Then the spring extends and the block travels back across the rough surface, sliding up the plane. The block travels a total distance d on rough horizontal surface. The correct expression for the maximum height h' that the block reaches on its return is:



(A) $mgh' = mgh - \mu mgd$
(B) $mgh' = mgh + \mu mgd$
(C) $mgh' = mgh + \mu mgd + kx^2$
(D) $mgh' = mgh - \mu mgd - kx^2$

2. In the Figure, the ball A is released from rest when the spring is at its natural length. For the block B, of mass M to leave contact with the ground at some stage, the minimum mass of A must be:

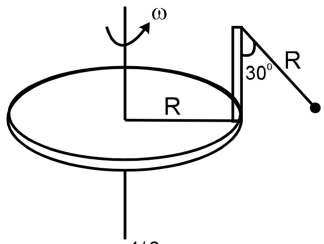


(A) 2 M
(B) M
(C) M/2
(D) A function of M and the force constant of the spring.

3. A particle is moving in a circle
(A) The resultant force on the particle must be towards the centre.
(B) The resultant force may be towards the centre.
(C) The direction of the angular acceleration and the angular velocity must be the same.
(D) The cross product of the tangential acceleration and the angular velocity will be zero.

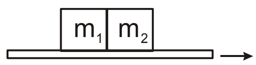
4. The potential energy function associated with the force $F = 4xy\,\hat{i} + 2x^2\,\hat{j}$ is :
(A) $U = -2x^2y$
(B) $U = -2x^2y$ + constant
(C) $U = 2x^2y$ + constant
(D) not defined

5. A disc of radius R has a light pole fixed perpendicular to the disc at the circumference which in turn has a pendulum of length R attached to its other end as shown in figure. The disc is rotated with a constant angular speed ω. The string is making an angle 30^0 with the rod. Then the angular speed ω of disc is:



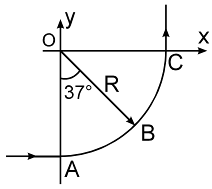
(A) $\left(\frac{\sqrt{3}\,g}{R}\right)^{1/2}$
(B) $\left(\frac{\sqrt{3}\,g}{2R}\right)^{1/2}$
(C) $\left(\frac{g}{\sqrt{3}\,R}\right)^{1/2}$
(D) $\left(\frac{2g}{3\sqrt{3}\,R}\right)^{1/2}$

6. Two blocks of masses m_1 and m_2 are placed in contact with each other on a horizontal platform. The coefficient of friction between the platform and the two blocks is the same. The platform moves with an acceleration. The force of interaction between the blocks is:



(A) zero only if $m_1 = m_2$
(B) zero in all cases
(C) non-zero only if $m_1 > m_2$
(D) non-zero only if $m_1 < m_2$.

7. A car initially traveling eastwards turns north by traveling in a quarter circular path of radius R metres at uniform speed as shown in figure. The car completes the turn in T second.
(a) What is the acceleration of the car when it is at B located at an angle of 37°. Express your a swers in terms of unit vectors ˆ and $\hat{j}$
(b) The magnitude of car's average acceleration during T second period.



Answers Key

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

7. (a) $\frac{\pi^2 R}{20T^2}(-3\,\hat{}\ + 4\hat{j})$ m/s^2

(b) $\frac{\pi R}{\sqrt{2}\,T^2}$ m/s^2

Hint & Solutions

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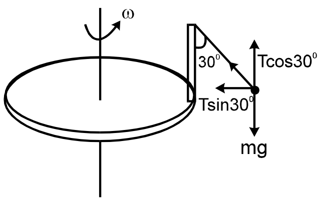
1. Final P.E. of block = Initial P.E. of block + work done by friction
$\therefore$ mgh' = mgh – μmgd

3. In uniform circular motion force is towards center but in nonuniform circular motion net force is not towards centre.

In retardation angular acceleration and angular velocity are opposite to each other.
Tangential acceleration and angular velocity are perpendicular to each other so cross product will not be zero.

4. $F_x = -\frac{U}{\ }$ or $F_y = -\frac{U}{\partial y}$, only (B) option satisfies the criterea.

5. (D) The bob of the pendulum moves in a circle of radius (R + Rsin30^0) = $\frac{3R}{2}$



Force equations : $T\sin 30^0 = m\left(\frac{3R}{2}\right)\omega^2$

$T\cos 30^0 = mg$

$\Rightarrow \tan 30^0 = \frac{3}{2}\frac{\omega^2 R}{g} = \frac{1}{\sqrt{3}}$

$\Rightarrow \omega = \sqrt{\frac{2g}{3\sqrt{3}R}}$ **Ans.**

6. For $a < \mu g$

$N = 0$

For $a > \mu g$

$$a_{m_1+m_2} = \frac{(m_1+m_2)a - \mu(m_1+m_2)g}{(m_1+m_2)}$$

$= a - \mu g$ w.r.t platform

For m_1

$m_1 a - \mu m_1 g + N = m_1 \times a_{m_1+m_2}$

$m_1 a - \mu m_1 g + N = m_1(a - \mu g)$

$N = 0.$

7. Speed of car is $v = \frac{\pi R}{2T}$ m/s

(a) The acceleration of car is $\frac{v^2}{R} = \frac{\pi^2 R}{4T^2}$ at B and is directed from B to O.

$\therefore$ Acceleration vector of car at B is

$$a = \frac{v^2}{R}(-\sin 37° \hat{i} + \cos 37° \hat{j}) = \frac{\pi^2 R}{20T^2}$$

$(-3\hat{i} + 4\hat{j})$ m/s²

(b) The magnitude of average acceleration of car is in time T is

$$\frac{|v_C - V_B|}{T} = \frac{\sqrt{2}v}{T} = \frac{\pi R}{\sqrt{2}T^2} \text{ m/s}^2$$