PHYSICS DPP
DAILY PRACTICE PROBLEMS

DPP No. 73

Total Marks : 22

Max. Time : 24 min.

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

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1	(3 marks, 3 min.)	[3, 3]
True or False (no negative marking) Q.2	(2 marks, 2 min.)	[2, 2]
Subjective Questions ('–1' negative marking) Q.3 to Q.4	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]

1. A particle performs S.H.M. of amplitude A along a straight line. When it is at a distance $\frac{\sqrt{3}}{2}$ A from mean position, its kinetic energy gets increased by an amount $\frac{1}{2}$ m ω^2 A^2 due to an impulsive force. Then its new amplitude becomes:

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

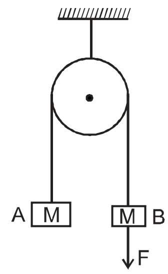
2. S_1 : If the internal forces within a system are conservative, then the work done by the external forces on the system is equal to the change in mechanical energy of the system.

S_2 : The potential energy of a particle moving along x-axis in a conservative force field is U = $2x^2 - 5x + 1$ in S.I. units. No other forces are acting on it. It has a stable equilibrium position at one point on x-axis.

S_3 : Internal forces can perform net work on a rigid body.

S_4 : Internal forces can perform net work on a non–rigid body.

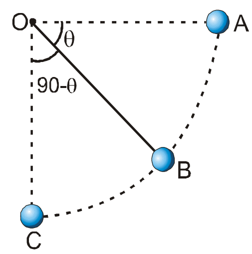
(A) T T F T (B) T F F T (C) F F T T (D) F T F T



3. Two particles A and B having equal mass are interconnected by a light inextensible string that passes over a smooth pulley. One of the masses is pulled downward by a constant force 'F' as shown in diagram, then find the acceleration of the centre of mass of the system (A + B).

4. A particle performs SHM of time period T, along a straight line. Find the minimum time interval to go from position A to position B. At A both potential energy and kinetic energy are same and at B the speed is half of the maximum speed.

COMPREHENSION



One end of a light string of length L is connected to a ball and the other end is connected to a fixed point O. The ball is released from rest at t = 0 with string horizontal and just taut. The ball then moves in vertical circular path as shown. The time taken by ball to go from position A to B is t_1 and from B to lowest position C is t_2. Let the velocity of ball at B is $\vec{v}_B$ and at C is $\vec{v}_C$ respectively.

5. If $|\vec{v}_C| = 2|\vec{v}_B|$ then the value of θ as shown is

(A) $\cos^{-1}\frac{1}{4}$ (B) $\sin^{-1}\frac{1}{4}$ (C) $\cos^{-1}\frac{1}{2}$ (D) $\sin^{-1}\frac{1}{2}$

6. If $|\vec{v}_C| = 2|\vec{v}_B|$ then :

(A) $t_1 > t_2$ (B) $t_1 < t_2$ (C) $t_1 = t_2$ (D) Information insufficient

7. If $|\vec{v}_C - \vec{v}_B| = |\vec{v}_B|$, then the value of θ as shown is :

(A) $\cos^{-1}\left(\frac{1}{4}\right)^{1/3}$ (B) $\sin^{-1}\left(\frac{1}{4}\right)^{1/3}$ (C) $\cos^{-1}\left(\frac{1}{2}\right)^{1/3}$ (D) $\sin^{-1}\left(\frac{1}{2}\right)^{1/3}$

Answers Key

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1. (C) **2.** (A) **3.** 0 **4.** $\frac{T}{24}$ **5.** (B)

6. (B) **7.** (B)

Hint & Solutions

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1. Due to impulse, the total energy of the particle becomes :

$$\frac{1}{2}m\omega^2A^2 + \frac{1}{2}m\omega^2A^2 = m\omega^2A^2$$

Let ; A' be the new amplitude.

$$\therefore \quad \frac{1}{2}m\omega^2(A')^2 = m\omega^2A^2$$

$\Rightarrow$ $A' = \sqrt{2}\,A.$ **Ans.** उत्तर

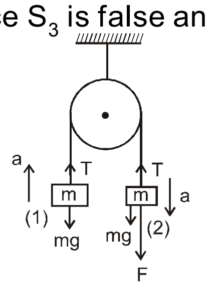
2. S_1 : The statement is true from Work Energy Theorem

$S_2 : F = -\frac{dU}{dx} = -4x + 5 \qquad \therefore$ SHM

S_3 & S_4 : A rigid body by definition cannot be expanded or compressed, thus it cannot store mechanical potential energy. Hence internal forces can do no work on rigid body, but can do work on non-rigid body. Hence S_3 is false and S_4 is true.

3. $Mg + F - T = Ma$

$T - Mg = Ma$



$F = 2Ma$

$a = \frac{F}{2M}$

$$a_{CM} = \frac{m_1a_1 + m_2a_2}{m_1 + m_2} = \frac{Ma + M(-a)}{M + m} = 0$$

4. $x_A = \frac{A}{\sqrt{2}}$

and for x_B ; $\frac{\omega A}{2} = \omega\sqrt{A^2 - x_B^2}$

or $x_B = \frac{\sqrt{3}}{2}A$

or $\omega t_A = \frac{\pi}{4}$ and $\omega t_B = \frac{\pi}{3}$

or $\omega (t_B - t_A) = \frac{\pi}{3} - \frac{\pi}{4}$

or $\frac{\pi}{3} - \frac{\pi}{4} = \frac{2\pi}{T}t$

or $t = \frac{T}{2\pi} \times \frac{\pi}{12} = \frac{T}{24}$

Ans. $\frac{T}{24}$

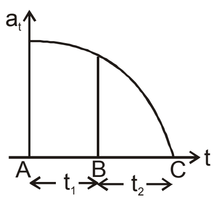
5. to 7 $v_B = \sqrt{2gL\sin\theta}$ and $v_C = \sqrt{2gL}$

If $v_C = 2v_B$

Then $2gL = 4\ (2gL \sin\theta)$

or $\sin\theta = \frac{1}{4}$ or $\theta = \sin^{-1}\frac{1}{4}$

6. Tangential acceleration is $a_t = g\cos\theta$,
which decreases with time.
Hence the plot of a_t versus time may be as shown in graph.



Area under graph in time interval $t_1 = v_B - 0 = v_B$

Area under graph in time interval $t_2 = v_C - v_B = v_B$

Hence area under graph in time t_1 and t_2 is same.

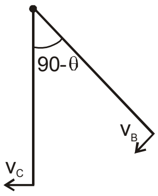
$\therefore t_1 < t_2$

7. $|\vec{v}_B - \vec{v}_C| = \sqrt{v_B^2 + v_C^2 - 2v_B v_C \sin\theta} = v_B$

$$\Rightarrow v_B^2 + v_C^2 - 2v_B v_C \sin\theta = v_B^2$$

$$v_C = 2v_B \sin\theta$$

$$\Rightarrow \sqrt{2g\ell} = 2\sqrt{2g\ell \sin\theta}\,\sin\theta$$



$$\therefore \sin^3\theta = \frac{1}{4} \Rightarrow \sin\theta = \left(\frac{1}{4}\right)^{1/3}$$

$$\theta = \sin^{-1}\left(\frac{1}{4}\right)^{1/3}$$