PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 72

Total Marks : 23

Max. Time : 23 min.

Topics : Center of Mass, Work, Power and Energy, Rigid Body Dynamic, Rotation, Simple Harmonic Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Multiple choice objective ('–1' negative marking) Q.3 to Q.4	(4 marks, 4 min.)	[8, 8]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]

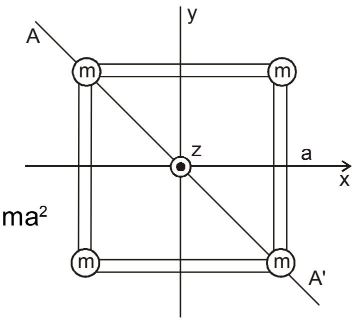
1. A continuous stream of particles of mass m and velocity *v*, is emitted from a source at a rate of *n* per second. The particles travel along a straight line, collide with a body of mass M and are buried in this body. If the mass M was originally at rest, its velocity when it has received N particles will be:

(A) $\frac{mvn}{Nm+n}$ (B) $\frac{mvN}{Nm+M}$ (C) $\frac{mv}{Nm+M}$ (D) $\frac{Nm+M}{mv}$

2. A particle is moving along x – axis has potential energy U = $(2 - 20x + 5x^2)$ Joules.
The particle is released at x = – 3. The maximum value of 'x' will be: [x is in meters and U is in joules]

(A) 5 m (B) 3 m (C) 7 m (D) 8 m

3. Four point mass, each of mass m are connected at a corner of a square of side 'a' , by massless rods as shown in the figure. x and y axis are in the plane of the system and z axis is perpendicular to the plane and passing through the centre of the square.

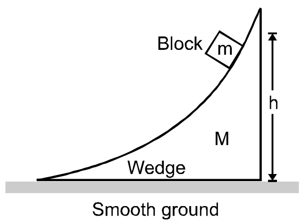


(A) Moment of inertia of the system about x axis is $I_x = ma^2$
(B) Moment of inertia of the system about y axis is $I_y = ma^2$
(C) Moment of inertia of the system about the diagonal axis AA' is $I_{AA'} = ma^2$
(D) Moment of inertia of the system about z axis is $I_z = ma^2$

4. The amplitude of a particle executing SHM about O is 10 cm. Then:
(A) when the K.E. is 0.64 of its maximum K.E. its displacement is 6 cm from O.
(B) when the displacement is 5 cm from O its K.E. is 0.75 times its maximum K.E.
(C) Its total energy of SHM at any point is equal to its maximum K.E.
(D) Its speed is half the maximum speed when its displacement is half the maximum displacement.

COMPREHENSION

A block of mass m slides down a wedge of mass M as shown. The whole system is at rest, when the height of the block is h above the ground. The wedge surface is smooth and gradually flattens. There is no friction between wedge and ground.



5. As the block slides down, which of the following quantities associated with the system remains conserved?
(A) Total linear momentum of the system of wedge and block
(B) Total mechanical energy of the complete system
(C) Total kinetic energy of the system
(D) Both linear momentum as well as mechanical energy of the system

6. If there would have been friction between wedge and block, which of the following quantities would still remain conserved ?
(A) Linear momentum of the system along horizontal direction
(B) Linear momentum of the system along vertical direction
(C) Linear momentum of the system along a tangent to the curved surface of the wedge
(D) Mechanical energy of the system

7. If there is no friction any where, the speed of the wedge, as the block leaves the wedge is :

(A) $m\sqrt{\frac{2gh}{(M+m)M}}$ (B) $M\sqrt{\frac{2gh}{(M+m)m}}$ (C) $(\sqrt{2gh})\frac{m}{M+m}$ (D) $(\sqrt{2gh})\frac{M}{M+m}$

Answers Key

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

Hint & Solutions

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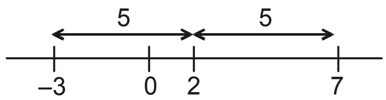
1. By momentum conservation (considering 'N particls of mass m + mass M' as system)
mV × N = (Nm + M) V'

2. $U = 2 - 20x + 5x^2$

$F = -\frac{dU}{dx} = 20 - 10x$

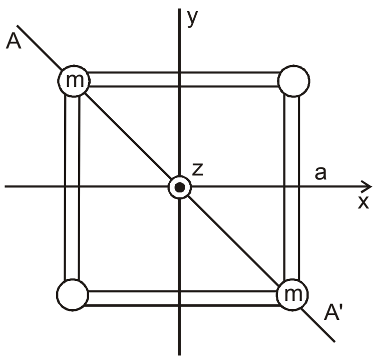
At equilibrium position ; F = 0
$20 - 10x = 0$
$\Rightarrow x = 2$

Since particle is released at x = – 3, therefore amplitude of particle is 5.



It will oscillate about x = 2 with an amplitude of 5.
∴ maximum value of x will be 7.

3.



$$I_{xx} = m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2$$

$= ma^2$

$$I_{yy} = m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2$$

$$= ma^2$$

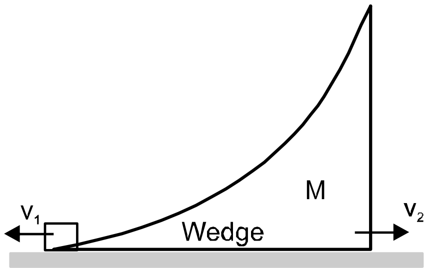
$$I_{AA'} = m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2 + 0 + 0 = ma^2$$

$$I_{zz} = \left(m\left(\frac{a}{2}\right)^2\right) \times 4 = 2ma^2$$

5. to 7 Linear momentum is conserved only in horizontal direction.

6. Net F_{ext} on system is zero in horizontal direction therefore linear momentum is conserved only in horizontal direction.

7. $mv_1 = Mv_2$ ....(i)



$$\frac{1}{2}mv_1^2 + \frac{1}{2}Mv_2^2 = mgh \quad ....(ii)$$

From (i) & (ii), $v_2 = m\sqrt{\frac{2gh}{(M+m)M}}$.