PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 55

Total Marks : 24

Max. Time : 24 min.

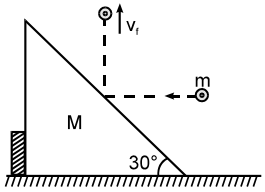
Topic : Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Comprehension ('–1' negative marking) Q.4 to Q.8	(3 marks, 3 min.)	[15, 15]

1. A glass ball collides with a smooth horizontal surface in xz plane with a velocity $\vec{v} = a\hat{i} - b\hat{j}$. If the coefficient of restitution of collision is e, then the velocity of the ball just after the impact will be :

(A) $a\hat{i} + b\hat{j}$ (B) $a\hat{i} + eb\hat{j}$ (C) $a\hat{i} - b\hat{j}$ (D) $a\hat{i} - eb\hat{j}$

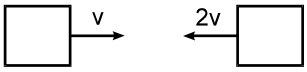
2. As shown in the figure a body of mass m moving horizontally with speed $\sqrt{3}$ m/s hits a fixed smooth wedge and goes up with a velocity v_f in the vertical direction. If $\angle$ of wedge is 30°, the velocity v_f will be:



(A) $\sqrt{3}$ m/s (B) 3 m/s

(C) $\frac{1}{\sqrt{3}}$ m/s (D) this is not possible

3. A plank of mass m moving with a velocity 'v' along a frictionless horizontal track and a body of mass m/2 moving with 2 v collides with plank elastically. Final speed of the plank is :



(A) $\frac{5v}{3}$ (B) $\frac{3v}{3}$ (C) $\frac{2v}{3}$ (D) none of these

COMPREHENSION

Two friends A and B (each weighing 40 kg) are sitting on a frictionless platform some distance d apart. A rolls a ball of mass 4 kg on the platform towards B which B catches. Then B rolls the ball towards A and A catches it. The ball keeps on moving back and forth between A and B. The ball has a fixed speed of 5 m/s on the platform.

4. Find the speed of A after he rolls the ball for the first time

(A) 0.5 m/s (B) 5m/s (C) 1 m/s (D) None of these

5. Find the speed of A after he catches the ball for the first time.

(A) $\frac{10}{21}$ m/s (B) $\frac{50}{11}$ m/s (C) $\frac{10}{11}$ m/s (D) None of these

6. Find the speeds of A and B after the ball has made 5 round trips and is held by A :

(A) $\frac{10}{11}$ m/s , $\frac{50}{11}$ m/s (B) $\frac{50}{11}$ m/s, $\frac{10}{11}$ m/s (C) $\frac{50}{11}$ m/s, 5 m/s (D) None of these

7. How many times can A roll the ball ?

(A) 6 (B) 5 (C) 7 (D) None of these

8. Where is the centre of mass of the system " A + B + ball" at the end of the nth trip? (Give the distance from the initail position of A)

(A) $\frac{10}{11}$ d (B) $\frac{10}{21}$ d (C) $\frac{50}{11}$ d (D) None of these

Answers Key

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

Hint & Solutions

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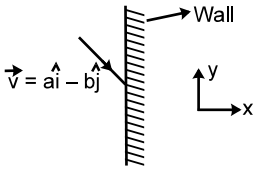
1. A collision which is not elastic changes only the normal component of velocity.
Here the normal component is – b. Hence it become (+eb)
after collision keeping the x-component (tangential)
as before collision.

$\Rightarrow \quad v_f = a\hat{i} + eb\hat{j}$.



Hence (B).

2. Velocity along the plane does not change

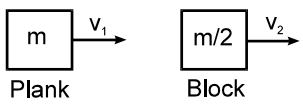
So $\sqrt{3}$ Sin f $o^o = V_1 \sin 30^o$

$\Rightarrow V_1 = 3$ m/s $> \sqrt{3}$ m/s

Which in impossible $\therefore$ **Ans. (D)**

3. Let the velocities of plank and body of mass $\frac{m}{2}$ move with speed v_1 and v_2 after collision as shown.

From conservation of momentum.



$$mv - \frac{m}{2}2v = mv_1 + \frac{m}{2}v_2$$

or $2v_1 + v_2 = 0$ ....(1)

From equation of coefficient of restitution.

$$e = 1 = \frac{v_2 - v_1}{v + 2v}$$

$\Rightarrow v_2 - v_1 = 3v$ .....(2)

Solving 1 and 2 we get

$v_1 = -v$

4 to 8 (A) 

from linear momentum conservation

$$M_A V = m_b 5 \Rightarrow v = \frac{4 \times 5}{40} = 0.5 \text{ m/s Ans.}$$

5. $m_A\, 0.5 + m_b\, 5 = (M_A + m_b)\, V_1 \quad V_1$

$$= \frac{40 \times 0.5 + 4 \times 5}{44} = \frac{40}{44} = \frac{10}{11} \text{ m/s} \quad \textbf{Ans.}$$

6. after throught the ball velocity of man A is 0.5 m/s

For man B $4 \times 5 = 40\, v_2 - 4 \times 5$

$\Rightarrow v_2 = 1$ m/s

velocity B is 1 m/s after through the ball

after through the ball second time, velocity of man A is

$4 \times 5 + 40 \times 0.5 = 40 \times v_3 - 4 \times 5$

$v_3 = 1.5$ m/s

similarly for man B $v_4 = 2$ m/s

after 5 round trip and man A hold the ball velocity of man B is 5 m/s

velocity of man A

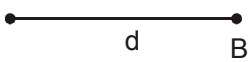
$4.5 \times 40 + 4 \times 5 = (40 + 4)v_5$

$$v_5 = \frac{50}{11} \text{ m/s} \quad \textbf{Ans.}$$

7. When man through the ball 6 times it velocity is greater than 5 m/s and velocity of B is 5 m/s therefor maximum number of times man A can through the ball is 6 .

8. $F_{ext} = 0$, Centre of mass of system cannot move

Initial position of centre of mass from A.



$$X_{cm} = \frac{40d}{44 + 40} = \frac{10}{21} d$$