

Linear momentum and system of particles

Assignment 1

Question 1.

(i). Two masses constrained to move in a horizontal plane collide. Given initially that $M_1 = 85\text{gm}$ and $M_2 = 200\text{gm}$, $\mathbf{v}_1 = 6.4\mathbf{i}$ cm/sec and $\mathbf{v}_2 = -6.7\mathbf{i} - 2\mathbf{j}$ cm/sec.

\mathbf{i} and \mathbf{j} are the unit vectors across x and y axis respectively

Find the velocity of centre of mass

- (a) $-2.8\mathbf{i} - 1.4\mathbf{j}$
- (b) $2.8\mathbf{i} + 1.4\mathbf{j}$
- (c) $2\mathbf{i} + 1.4\mathbf{j}$
- (d) none of the above

(ii). Find the total linear momentum of the system

- (a) $-798\mathbf{i} - 400\mathbf{j}$
- (b) $-796\mathbf{i} + 400\mathbf{j}$
- (c) $600\mathbf{i} + 400\mathbf{j}$
- (d) none of the above

(iii). Find the velocity in the reference of frame in which centre of mass is at rest

- (a) $9.2\mathbf{i} - 1.4\mathbf{j}$, $-3.9\mathbf{i} - 0.6\mathbf{j}$
- (b) $9.2\mathbf{i} + 1.4\mathbf{j}$, $-3.9\mathbf{i} - 0.6\mathbf{j}$
- (c) $-9.2\mathbf{i} + 1.4\mathbf{j}$, $-3.9\mathbf{i} - 0.6\mathbf{j}$
- (d) none of the above

(iv) Let \mathbf{w}_1 and \mathbf{w}_2 are final velocity

now we know $|\mathbf{w}_1| = 9.2$ and $\mathbf{w}_2 = 4.4\mathbf{i} + 1.9\mathbf{j}$ cm/sec

find the direction of \mathbf{w}_1

- (a) 26° with respect to x axis
- (b) 84° with respect to x axis
- (c) -84° with respect to x axis
- (d) none of the above

Question 2.

A straight rod of length L has one of its end at origin and other at (L, 0). If the mass per unit length of rod is $Ax + B$. Find the centre of mass

- (a) $L(2AL + 3B)/(3AL + 6B)$
- (b) $L(AL + 3B)/(AL + 6B)$
- (c) $L(AL - B)/(AL + 2B)$
- (d) none of the above

Question 3.

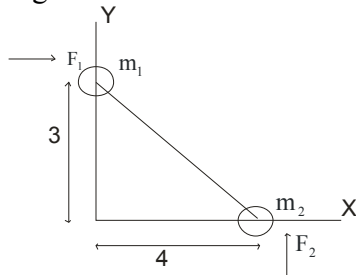
A uniform solid sphere has a spherical hole in it. Find the centre of mass

- (a) $x_{cm} = -a^3b/(R^3 - a^3)$, $y_{cm} = 0$, $z_{cm} = 0$

- (b) $x_{cm} = a^3b/(R^3-a^3)$, $y_{cm} = 0$, $z_{cm} = 0$
 (c) $x_{cm} = b^3a/(R^3-a^3)$, $y_{cm} = 0$, $z_{cm} = 0$
 (d) none of the above

Question 4.

(i). Two mass $m_1 = 10$ and $m_2 = 6$ are joined by a rigid bar of negligible mass as shown in Figure



Being initially at rest, they are subjected to force $F_1 = 8\mathbf{i}$ N and $F_2 = 6\mathbf{j}$ N

Find the coordinate of their centre of mass as a function of time

- (a) $\mathbf{i}(1.5 - 0.25t^2) + \mathbf{j}(1.88 - 0.188t)$
 (b) $\mathbf{i}(1.5 + 0.25t^2) + \mathbf{j}(1.88 + 0.188t^2)$
 (c) $(1.5 + 0.188t^2)\mathbf{i}$
 (d) none of the above

(ii). Find the total linear momentum as function of time

- (a) $(8\mathbf{i} + 6\mathbf{j})t$
 (b) $(8\mathbf{i} - 6\mathbf{j})t$
 (c) $(2\mathbf{i} + 6\mathbf{j})t$
 (d) none of the above

Question 5.

A man of mass m standing is on a block of mass M . The system is at rest. The man moves relative in x direction to the block with velocity v' and then stops.

Find the velocity of centre of mass

- (a) v'
 (b) 0
 (c) $mv'/M + m$
 (d) none of the above

Question 6.

Three bodies form an isolated system. There are $m_1 = m_2 = 2m$ and $m_3 = 3m$. They have different direction, but all have the same initial speed v_0 . One or more elastic collision between the pair of the bodies where otherwise do not intersect. Find the maximum possible final speed of each of the three bodies.

- (a) $3v_0, 2v_0, v_0$
 (b) $v_0, 2v_0, 3v_0$
 (c) $2.4v_0, 1.73v_0, 1.41v_0$

(d) none of the above

Question 7.

A ball is dropped from height h on a floor where coefficient of restitution is e . Find the time required by the ball to stop rebounding

- (a) $\sqrt{(2h/g)} (1 + e/1 - e)$
- (b) $\sqrt{(2h/g)} (1 + e)$
- (c) $\sqrt{(2h/g)} (1 - e/1 + e)$
- (d) none of the above

Question 8. Matrix match type-

In a system of particle

Column A

- (a) external force are present, but no internal force
- (b) internal force are present, but no external force
- (c) both no external and internal force
- (d) both internal and external force are present

Column B

- (P) total momentum will remain constant
- (Q) total momentum will not remain constant
- (R) centre of mass will accelerate
- (S) centre of mass will not accelerate

Answers

1. (i) – (a) : (ii) – (a) : (iii) – (b) : (iv) – (c)
2. (a)
3. (a)
4. (i) - (b) : (ii) – (a)
5. (b)
6. (c)
7. (a)
8. Matrix match type : (a) → (Q), (R) : (b) → (P), (S) : (c) → (P), (S) : (d) → (P), (S)

