

## 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)  $26^\circ$  with respect to x axis
- (b)  $84^\circ$  with respect to x axis
- (c)  $-84^\circ$  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.

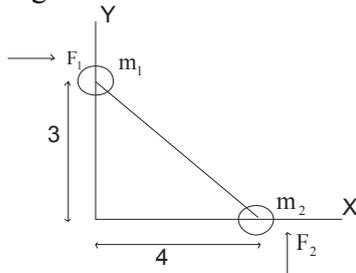
A uniform solid sphere has a spherical hole in it. Find the centre of mass

- (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)

