

**Q. 8. Before Mass After**

$$\begin{array}{ccc} 8\vec{i} + 4\vec{j} & m & x\vec{i} + 4\vec{j} \\ 0\vec{i} + 0\vec{j} & 2m & y\vec{i} + 0\vec{j} \end{array}$$

(i)  $8\vec{i} + 4\vec{j} \perp x\vec{i} + 4\vec{j}$

$$\therefore \frac{4}{8} \cdot \frac{4}{x} = -1$$

$$\Rightarrow x = -2$$

$$\therefore \text{New velocity} = -2\vec{i} + 4\vec{j} \text{ m/s}$$

(ii)  $m(8) + 2m(0) = m(x) + 2my$

$$8m = -2m + 2my$$

$$\therefore y = 5$$

$$\therefore \text{Its velocity} = 5\vec{i} \text{ m/s}$$

(iii)  $\frac{x-y}{8-0} = -e$

$$\therefore \frac{-2-5}{8} = -e$$

$$\therefore e = \frac{7}{8}$$

<b>Q. 9. (i) Before (Mass) After</b>		
$p\vec{i} + q\vec{j}$	4	$r\vec{i} + q\vec{j}$
$x\vec{i} + y\vec{j}$	2	$0\vec{i} + 0\vec{j}$

Momentum in the  $\vec{j}$ -direction is conserved

$$\Rightarrow 4p + 2x = 4r$$

$$\Rightarrow 2p + x = 2r \dots \text{Equation 1}$$

**N.E.L.**

$$\frac{r-0}{p-x} = -\frac{1}{2}$$

$$\Rightarrow p - x = -2r \dots \text{Equation 2}$$

Adding equations 1 and 2 we get

$$3p = 0$$

$$\Rightarrow p = 0$$

$\vec{j}$ -velocity of 2nd sphere is unchanged

$$\Rightarrow y = 0$$

$\Rightarrow$  Velocities before impact were  $q\vec{j}$  and  $x\vec{i}$  ... these are  $\perp$  to each other.

(ii) **4 kg mass:**

$$\text{K.E.}_{\text{before}} = \frac{1}{2}(4)q^2 = 2q^2$$

$$\begin{aligned} \text{K.E.}_{\text{after}} &= \frac{1}{2}(4)(r^2 + q^2) \\ &= 2(r^2 + q^2) \end{aligned}$$

$$\begin{aligned} \text{Gain} &= 2(r^2 + q^2) - 2q^2 \\ &= 2r^2 \end{aligned}$$

**2 kg mass:**

$$\text{K.E.}_{\text{before}} = \frac{1}{2}(2)x^2 = x^2$$

... but  $x = 2r$  (from **Equation 1**)

$$\Rightarrow \text{K.E.}_{\text{before}} = (2r)^2 = 4r^2$$

$$\text{K.E.}_{\text{after}} = 0$$

$$\Rightarrow \text{Loss} = 4r^2$$

$$\Rightarrow \text{Gain in K.E. of 4 kg mass} = \frac{1}{2}$$

(Loss in K.E. of 2 kg mass)

**Q. 10. (i) First collision between P and Q**

<b>Before (Mass) After</b>		
P: $12u$	4	$p$
Q: $0$	8	$q$

$$4(12u) + 8(0) = 4(p) + 8(q)$$

$$\Rightarrow p + 2q = 12u \dots \text{Equation 1}$$

$$\frac{p-q}{12u-0} = -\frac{1}{4}$$

$$\Rightarrow -p + q = 3u \dots \text{Equation 2}$$

Adding equations 1 and 2 we get

$$3q = 15u$$

$$\Rightarrow q = 5u \dots \text{speed of Q after 1st collision}$$

$$p = q - 3u \dots \text{from Equation 2}$$

$$\Rightarrow p = 5u - 3u$$

$$\Rightarrow p = 2u \dots \text{speed of P after 1st collision}$$

Collision of Q with the wall

$$\frac{\text{NEW}}{\text{OLD}} = -e$$

$$\Rightarrow \frac{v}{5u} = -e$$

$$\Rightarrow v = -5eu$$