

WEEKLY TEST TYM -1 TEST - 19 Rajpur Road
SOLUTION Date 01-09-2019

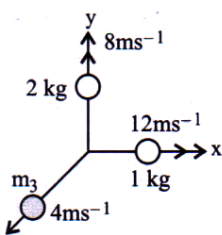
[PHYSICS]

1.

The situation of the problem is as shown in the figure. According to law of conservation of linear momentum.

$$\vec{p}_1 + \vec{p}_2 + \vec{p}_3 = 0$$

$$\therefore \vec{p}_3 = -(\vec{p}_1 + \vec{p}_2)$$



Here,

$$\vec{p}_1 = (1\text{kg})(12\text{ms}^{-1})\hat{i} = 12\hat{i}\text{kgms}^{-1}$$

$$\vec{p}_2 = (2\text{kg})(8\text{ms}^{-1})\hat{j} = 16\hat{j}\text{kgms}^{-1}$$

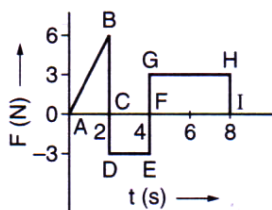
$$\therefore \vec{p}_3 = -(12\hat{i} + 16\hat{j})\text{kgms}^{-1}$$

The magnitude of \vec{p}_3 is :

$$p_3 = \sqrt{(12)^2 + (16)^2} = 20\text{kgms}^{-1}$$

$$\therefore m_3 = \frac{p_3}{v_3} = \frac{20\text{kgms}^{-1}}{4\text{ms}^{-1}} = 5\text{kg}$$

2.



Change in momentum = Area under $F-t$ graph in that interval

$$= \text{Area of } \triangle ABC - \text{Area of rectangle } CDEF + \text{Area of rectangle } FGHI$$

$$= \frac{1}{2} \times 2 \times 6 - 3 \times 2 + 4 \times 3 = 12\text{Ns}$$

3.

Let \vec{v}' be velocity of third piece of mass $2m$. Initial momentum, $\vec{P}_i = 0$ (As the body is at rest). Final momentum,

$$\vec{P}_f = mv\hat{i} + mv\hat{j} + 2m\vec{v}'$$

According to law of conservation of momentum

$$\vec{P}_i = \vec{P}_f$$

$$0 = mv\hat{i} + mv\hat{j} + 2m\vec{v}'$$

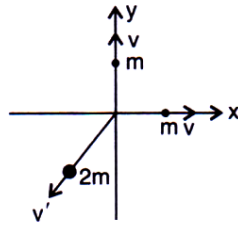
$$\vec{v}' = -\frac{v}{2}\hat{i} - \frac{v}{2}\hat{j}$$

The magnitude of \vec{v}' is

$$v' = \sqrt{\left(-\frac{v}{2}\right)^2 + \left(-\frac{v}{2}\right)^2} = \frac{v}{\sqrt{2}}$$

Total kinetic energy generated due to explosion

$$\begin{aligned} &= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}(2m)v'^2 \\ &= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}(2m)\left(\frac{v}{\sqrt{2}}\right)^2 = mv^2 + \frac{mv^2}{2} \\ &= \frac{3}{2}mv^2 \end{aligned}$$



4.

Given that,

$$\vec{F} = (2t\hat{i} + 3t^2\hat{j}) \text{ and } \vec{a} = 2t\hat{i} + 3t^2\hat{j}$$

$$\text{Hence, } v = \int_0^t a dt = t^2\hat{i} + t^3\hat{j}$$

$$\therefore P = \vec{F} \cdot \vec{v} = 2t \cdot t^2 + 3t^2 \cdot t^3 = 2t^3 + 3t^5$$

5.

Here, $m_1 = m, m_2 = 2m$

$$u_1 = 2 \text{ m/s, } u_2 = 0$$

Coefficient of restitution, $e = 0.5$

Let v_1 and v_2 be their respective velocities after collision.

Applying the law of conservation of linear momentum, we get,

$$\begin{aligned} m_1u_1 + m_2u_2 &= m_1v_1 + m_2v_2 \\ \therefore m \times 2 + 2m \times 0 &= m \times v_1 + 2m \times v_2 \\ \text{or } 2m &= mv_1 + 2mv_2 \\ \text{or } 2 &= (v_1 + 2v_2) \quad \dots(i) \end{aligned}$$

By definition of coefficient of restitution,

$$\begin{aligned} e &= \frac{v_2 - v_1}{u_1 - u_2} \\ \text{or } 0.5(u_1 - u_2) &= (v_2 - v_1) \\ 0.5(2 - 0) &= (v_2 - v_1) \\ 1 &= v_2 - v_1 \quad \dots(ii) \end{aligned}$$

Solving equations (i) and (ii), we get,

$$v_1 = 0 \text{ m/s, } v_2 = 1 \text{ m/s}$$

6.

According to conservation of momentum

$$m_1v_1 + m_2v_2 = (m_1 + m_2)v,$$

where v is common velocity of the two bodies.

$$m_1 = 0.1 \text{ kg}, m_2 = 0.4 \text{ kg}$$

$$v_1 = 1 \text{ m/s}, v_2 = -0.1 \text{ m/s}$$

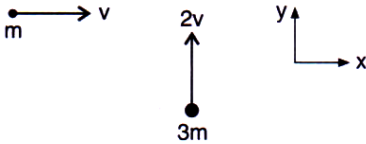
$$\therefore 0.1 \times 1 + 0.4 \times (-0.1) = (0.1 + 0.4)v$$

$$\text{or } 0.1 - 0.04 = 0.5v,$$

$$v = \frac{0.06}{0.5} = 0.12 \text{ m/s.}$$

Hence, distance covered = $0.12 \times 10 = 1.2 \text{ m}$

7.



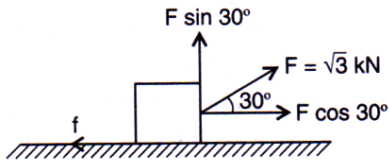
According to conservation of momentum, we get

$$mv\hat{i} + (3m)2v\hat{j} = (m + 3m)v'$$

where v' is the final velocity after collision

$$v' = \frac{1}{4}v\hat{i} + \frac{6}{4}v\hat{j} = \frac{1}{4}v\hat{i} + \frac{3}{2}v\hat{j}.$$

8.



The component of applied force F in the direction of motion is $F \cos 30^\circ$.

The work done by the applied force is,

$$W = (F \cos 30^\circ)S = \sqrt{3} \times 10^3 \times \frac{\sqrt{3}}{2} \times 10 \text{ J}$$

$$= 15 \times 10^3 \text{ J} = 15 \text{ kJ.}$$

9.

Mass of water falling/second = 15 kg , $h = 60 \text{ m}$

$g = 10 \text{ m/s}^2$, loss = 10%, i.e., 90% is used

Power generated = $15 \times 10 \times 60 \times 0.9 = 8100 \text{ W}$
 $= 8.1 \text{ kW}$

$$10. \quad mv = Mv' \quad \text{or} \quad v' = \left(\frac{m}{M}\right)v$$

$$\text{Total KE of the bullet and the gun} = \frac{1}{2}mv^2 + \frac{1}{2}Mv'^2$$

$$\text{Total KE} = \frac{1}{2}mv^2 + \frac{1}{2}M \cdot \frac{m^2}{M^2}v^2$$

$$\text{Total KE} = \frac{1}{2}mv^2 \left[1 + \frac{m}{M}\right]$$

$$\text{or} \quad 1.05 \times 1000 \text{ J} = \left[\frac{1}{2} \times 0.2\right] \left[1 + \frac{0.2}{4}\right] v^2$$

$$\text{or} \quad v^2 = \frac{4 \times 1.05 \times 1000}{0.1 \times 4.2} = (100)^2;$$

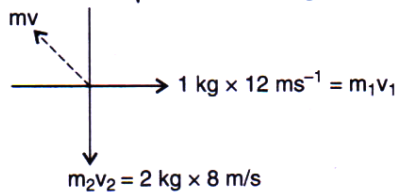
$$\therefore v = 100 \text{ ms}^{-1}$$

11.

When an explosion breaks a rock, by the law of conservation of momentum, initial momentum which is zero, is equal to total momentum of three pieces.

Total momentum of the two pieces 1 kg and 2 kg

$$= \sqrt{12^2 + 16^2} = 20 \text{ kg m s}^{-1}$$



The third piece has the same momentum and in the direction opposite to the resultant of these two momenta.

\therefore Momentum of the third piece = 20 kg m s^{-1} ;

Velocity = 4 m s^{-1}

\therefore Mass of the 3rd piece = $\frac{mv}{v} = \frac{20}{4} = 5 \text{ kg}$.

[CHEMISTRY]

22.

$$P_1 = 100, V_1 = 100, V_2 = 110$$

$$P_2V_2 = P_1V_1 \Rightarrow P_2 = \frac{100 \times 100}{110} = 90.9$$

23.

$$\frac{r_{\text{CH}_4}}{r_{\text{SO}_2}} = \frac{\left(\frac{V}{t}\right)_{\text{CH}_4}}{\left(\frac{V}{t}\right)_{\text{SO}_2}} = \sqrt{\frac{M_{\text{SO}_2}}{M_{\text{CH}_4}}}$$

$$\frac{200}{400} = \sqrt{\frac{64}{16}} = 2$$

$$\frac{t}{40} = 2 \quad \Rightarrow \quad t = 80 \text{ sec}$$