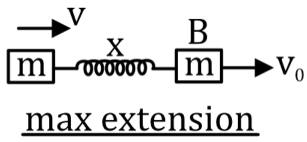
DPP – 05

SOLUTION

1. $P_i = P_f$

$mv_0 = 2mv$

$\Rightarrow v = \frac{v_0}{2}$



$W.D_{spring} = k_f - k_i$

$$-\frac{k}{2}(x^2 - 0^2) = \frac{1}{2}(2m)\frac{v_0^2}{4} - \frac{1}{2}mv_0^2$$

$$\Rightarrow x = v_0\sqrt{\frac{m}{2k}}$$

2. $I = F\Delta t$

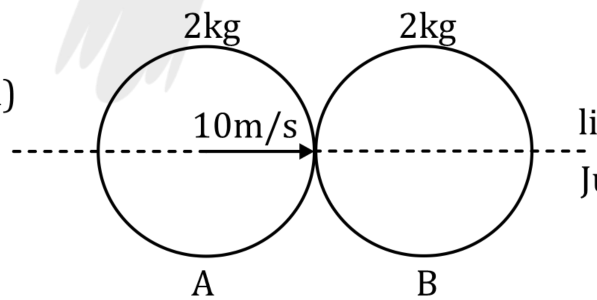
$I = mg\ \Delta T$

$$T = \frac{2\mu \sin\ \theta}{g}$$

$$I = mg \times \frac{2\mu y}{g}$$

$I = 120\ N - sec$

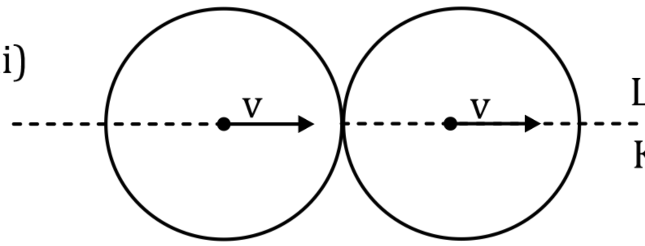
3. → (i)



line of collision

Just before collision

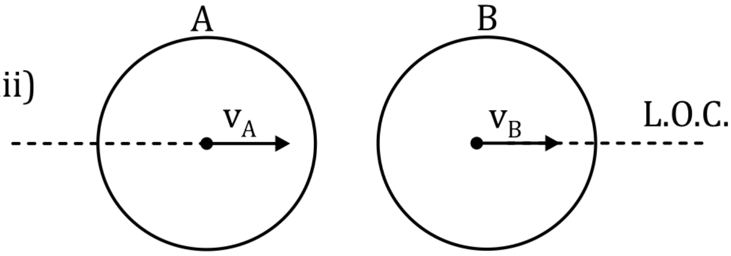
→ (ii)



L.O.C.

$K.E_{min}$

(iii)

→ 

After collision.

$P_1 = P_3 \Rightarrow 2 \times 10 = 2v_A + 2v_B$

$v_A + v_B = 10$ ____(i)

$e = \frac{v_B - v_A}{10}$

$v_B - v_A = 2$ ____(ii)

$\frac{v_A + v_B = 10}{2v_B = 12}$

$v_B = 6 m/s$

$v_A = 4\ m/s$

$\rightarrow\ P_1 = P_2$

$\rightarrow 2 \times 10 = 2v + 2v$

$4v = 2 \times 10$

$v = 5\ m/s$

$K \cdot E_{min} = \frac{1}{2} \times 2 \times 5^2 + \frac{1}{2} \times 2 \times 5^2$

$= 50\ J$

$\rightarrow |\Delta P_A| = |P_{A_f} - P_{A_i}| = 2|4 - 10|$

$= 12\ kg - m/s$

$\rightarrow |\Delta P_B| = |P_{B_f} - P_{B_i}| = 2|6 - 0| = 12\ kg - m/s$

$K \cdot Ei = \frac{1}{2} \times 2 \times 10^2 = 100$

$\Delta K = 50$

4. When the two marbles strikes the system of marbles, by head on elastic collisions of identical spherical bodies we can say that these two marbles will come to rest and next two will be set in motion and same phenomenon happens for next set of marbles hence (B) is correct.

5. Energy lost in the collisions $= \frac{1}{4} m U_{r_{rel}}^2 (1 - e^2)$.

6. Mass of neutron, $m_1 = 1$ unit

Mass of nucleus, $m_2 = A$ units

Here, $u_1 = v$ and $u_2 = 0$

Therefore, velocity of neutron after collision,

$$v = \frac{m_1 - m_2}{m_1 + m_2} u_1 + \frac{2m_2}{m_1 + m_2} u_2$$

$$\therefore \; v_1 = \frac{1 - A}{1 + A} v$$

Kinetic energy of neutron after collision,

$$k_2 = \frac{1}{2}(1)\left[\frac{1-A}{1+A}\right]^2 v^2 \qquad \_\_\_(i)$$

Kinetic energy of neutron before collision,

$$k_2 = \frac{1}{2}(1)v^2 \qquad \_\_\_(ii)$$

$$\frac{k_2}{k_1} = \left(\frac{1-A}{1+A}\right)^2 = \left(\frac{A-1}{A+1}\right)^2$$

7. $m_1 = m, m_2 = m$

$u_1 = u, u_2 = 0$

after collision velocity of first sphere

$$v_1 = \left(\frac{m_1 - em_2}{m_1 + m_2}\right) u_1 + \frac{m_2}{m_1 + m_2}(1 + e) u_2$$

$$v_1 = \frac{m - em}{m + m}u + 0$$

$$v_1 = \frac{m}{2m}(1 - e)u = \frac{1 - e}{2}u$$

velocity of second sphere after collision is

$$v_2 = \left(\frac{m_2 - em_1}{m_1 + m_2}\right)u_2 + \frac{m_1}{m_1 + m_2}(1 + e)u_1$$

$$v_2 = 0 + \frac{m}{2m}(1 + e)u$$

$$v_2 = \frac{(1 + e)u}{2}$$

$$\frac{v_1}{v_2} = \frac{v_A}{v_B} = \frac{1 - e}{2} \times \frac{2}{1 + e} = \frac{1 - e}{1 + e}$$

8. Let initial velocity of m_1 is u and after collision,

velocities of m_1&m_2 are v_1&v_2 respectively.

$$v_1 = \frac{m_1 - m_2}{m_1 + m_2}u \quad \Rightarrow \quad v_2 = \frac{2m_1}{m_1 + m_2}u$$

Kinetic energy of m_2 after collision,

$$k_2 = \frac{1}{2}m_2 \cdot \left(\frac{2m_1}{m_1 + m_2}u\right)^2$$

$$k_2 = \frac{1}{2}\frac{m_2 \cdot (4m_1^2u^2)}{(m_1 + m_2)^2}$$

Kinetic energy of m_1 before collision,

$$k_i = \frac{1}{2}m_1u^2$$

$$f = \frac{k_2}{k_i} = \frac{4m_1^2m_2u^2}{2(m_1 + m_2)^2} \times \frac{2}{m_1u^2}$$

$$\Rightarrow \ f = \frac{4m_1m_2}{(m_1 + m_2)^2}$$