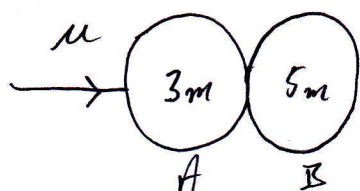


2013 Q5.

Note: PCM = Principle of Conservation of Momentum
NEL = Newton's Experimental Law.

(a) (i)



$$\text{PCM} \Rightarrow m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$\text{PCM} \Rightarrow 3m u + 5m(0) = 3m v_1 + 5m v_2 \quad \textcircled{1}$$

$$\text{NEL} \Rightarrow \frac{v_1 - v_2}{u_1 - u_2} = -e$$

$$\Rightarrow \frac{v_1 - v_2}{u - 0} = -e$$

$$\Rightarrow v_1 - v_2 = -e(u) \quad \textcircled{2}$$

$$3m u = 3m v_1 + 5m v_2 \quad \textcircled{1}$$

$$\Rightarrow 3u = 3v_1 + 5v_2 \quad \textcircled{1}$$

$$-5eu = 5v_1 - 5v_2 \quad \textcircled{2} \times 5$$

$$(3-5e)u = 8v_1$$

$$\Rightarrow \frac{u}{8}(3-5e) = v_1 \quad *$$

Similarly: $3u = 3v_1 + 5v_2 \quad \textcircled{1}$

$$-eu = v_1 - v_2 \quad \textcircled{2}$$

$$3eu = -3v_1 + 3v_2 \quad \textcircled{2} \times -3$$

$$3u = 3v_1 + 5v_2 \quad \textcircled{1}$$

$$3u(1+e) = 8v_2$$

$$\Rightarrow \frac{3u}{8}(1+e) = v_2 \quad *$$

$$(ii) \quad \vec{I} = m\vec{v} - m\vec{u}$$

$$2mu = 5mV_2 - 5m(0) \quad \text{for B.}$$

$$\Rightarrow 2mu = 5m \left(\frac{3u}{8} (1+e) \right)$$

$$\Rightarrow 2mu = \frac{15mu}{8} (1+e)$$

$$\Rightarrow 16mu = 15mu(1+e)$$

$$\Rightarrow 16 = 15(1+e)$$

$$\Rightarrow \frac{16}{15} = 1+e$$

$$\Rightarrow \frac{16}{15} - 1 = e$$

$$\Rightarrow \frac{1}{15} = e$$

$$(b) (i) \quad v^2 = u^2 + 2as$$

Down: $v^2 = 0 + 2gh$

$$\Rightarrow v = \sqrt{2gh}$$

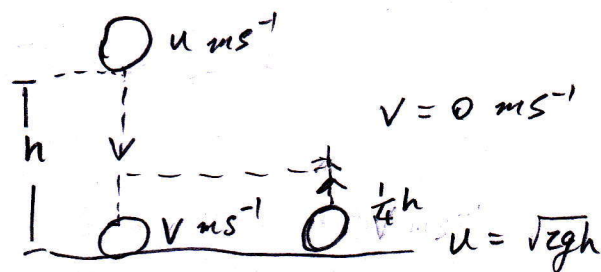
Up: $v^2 = u^2 + 2as$

$$0 = (e\sqrt{2gh})^2 - 2g\left(\frac{h}{4}\right)$$

$$\Rightarrow \frac{2gh}{4} = e^2 2gh$$

$$\Rightarrow \frac{1}{4} = e^2$$

$$\Rightarrow \frac{1}{2} = e$$



$$(ii) \quad v^2 = u^2 + 2as$$

$$\Rightarrow 0 = (e_1 \sqrt{2gh_1})^2 - 2g \frac{h_1}{9}$$

$$\Rightarrow \frac{2}{9} gh_1 = e_1^2 2gh_1$$

$$\Rightarrow \frac{1}{9} = e_1^2$$

$$\Rightarrow \frac{1}{3} = e_1$$

$$(iii) \quad v^2 = u^2 + 2as$$

$$\Rightarrow 0 = (e_2 \sqrt{2gh_2})^2 - 2g \left(\frac{h_2}{16} \right)$$

$$\Rightarrow \frac{2gh_2}{16} = e_2^2 2gh_2$$

$$\Rightarrow \frac{1}{16} = e_2^2$$

$$\Rightarrow \frac{1}{4} = e_2$$

$$e \propto 2.5e_1 \Rightarrow e = k \cdot 2.5e_1$$

$$\Rightarrow \frac{1}{2} = k \cdot 2.5 \frac{1}{3}$$

$$\Rightarrow \frac{3}{2 \times 2.5} = k$$

$$\Rightarrow 0.6 = k$$

$$e = 0.6 \times x \times e_2$$

$$\Rightarrow \frac{1}{2} = 0.6 \times x \times \frac{1}{4} \Rightarrow x = \frac{10}{3} \text{ cm.}$$