

- (ii) Firstly, find how long it takes for sphere to hit wall.

$$\begin{aligned} \text{speed} &= u(1 + e) \\ \text{distance} &= 1 \text{ metre} \\ \text{time} &= \frac{\text{distance}}{\text{speed}} \\ &= \frac{1}{u(1 + e)} \text{ s} \end{aligned}$$

Find the distance travelled by other sphere in this time.

$$\begin{aligned} \text{speed} &= u(1 - e) \\ \text{time} &= \frac{1}{u(1 + e)} \\ \text{distance} &= \text{speed} \times \text{time} \\ &= u(1 - e) \left[\frac{1}{u(1 + e)} \right] \\ &= \frac{1 - e}{1 + e} \\ \Rightarrow \text{distance apart} &= 1 - \frac{1 - e}{1 + e} \\ &= \frac{1 + e - 1 + e}{1 + e} \\ &= \frac{2e}{1 + e} \end{aligned}$$

- (iii) Find the speed of sphere after colliding with wall.

$$\begin{aligned} \frac{\text{NEW}}{\text{OLD}} &= -e \\ \Rightarrow \frac{v}{u(1 + e)} &= -e \\ \Rightarrow v &= -eu(1 + e) \\ \vec{v}_A &= u(1 - e) \\ \vec{v}_B &= -eu(1 + e) \\ \vec{v}_{AB} &= \vec{v}_A - \vec{v}_B \\ &= u(1 - e) + eu(1 + e) \\ &= u - eu + eu + e^2u \\ &= u(1 + e^2) \\ \text{time} &= \frac{\text{relative distance}}{\text{relative speed}} \\ &= \frac{\frac{2e}{1 + e}}{u(1 + e^2)} \\ &= \frac{2e}{u(1 + e)(1 + e^2)} \end{aligned}$$

Look at how far the sphere has moved away from the wall in this time.

$$\begin{aligned} \text{distance} &= \text{speed} \times \text{time} \\ \Rightarrow \text{distance} &= eu(1 + e) \left[\frac{2e}{u(1 + e)(1 + e^2)} \right] \\ &= \frac{2e^2}{1 + e^2} \end{aligned}$$

- Q. 19.** (i) Gain in K.E. = Loss in P.E.

$$\begin{aligned} \Rightarrow \frac{1}{2}mv^2 &= mgh \\ \Rightarrow \frac{1}{2}(0.6)v^2 &= (0.6)g(0.5\cos 60^\circ) \\ \Rightarrow v^2 &= \frac{g}{2} \\ \Rightarrow v &= \sqrt{\frac{g}{2}} = 2.21 \text{ m/s} \end{aligned}$$

- (ii) **Before (Mass) After**

$\sqrt{\frac{g}{2}}$	0.6	p
0	0.8	q

$$0.6\left(\sqrt{\frac{g}{2}}\right) + 0.8(0) = 0.6(p) + 0.8(q)$$

... multiply by 5

$$\Rightarrow 3p + 4q = 3\sqrt{\frac{g}{2}} \quad \dots \text{Equation 1}$$

$$\frac{p - q}{\sqrt{\frac{g}{2}} - 0} = -\frac{1}{11}$$

$$\Rightarrow 11p - 11q = -\sqrt{\frac{g}{2}} \quad \dots \text{Equation 2}$$

$$\text{Eq. 1} (\times 11): \quad 33p + 44q = 33\sqrt{\frac{g}{2}}$$

$$\text{Eq. 2} (\times -3): \quad -33p + 33q = 3\sqrt{\frac{g}{2}} \quad \text{add}$$

$$77q = 36\sqrt{\frac{g}{2}}$$

$$\begin{aligned} \Rightarrow q &= \frac{36}{77}\sqrt{\frac{g}{2}} \\ &= 1.03 \text{ m/s} \end{aligned}$$

$$p = \frac{3\sqrt{\frac{g}{2}} - 4q}{3} \quad \dots \text{from Equation 1}$$

$$\Rightarrow p = 0.84 \text{ m/s}$$