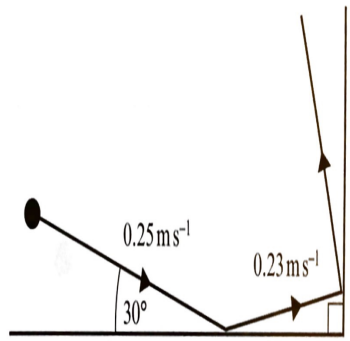
Oblique Impact

E/P **3** Two smooth vertical walls stand on a smooth horizontal surface and intersect at right angles. A smooth sphere of mass 0.1 kg is moving in the xy-plane such that it collides with the first wall at a speed of $0.25\,\text{m s}^{-1}$ at an angle of 30° to the wall. The coefficient of restitution between the sphere and both walls is e. Given that after the first collision the sphere is moving with speed $0.23\,\text{m s}^{-1}$, work out:



a the direction in which the sphere is moving **(2 marks)**

b the value of e. **(2 marks)**

The sphere then moves on to collide with the second wall.

c Calculate the kinetic energy of the sphere after the second collision. **(6 marks)**

b) $V_x \longrightarrow = .25\cos 30 = \frac{25\sqrt{3}}{2}$

$V_y = .25\sin 30 \times e$

$= \frac{.25e}{2}$

$\sqrt{V_x^2 + V_y^2} = 0.23$

$\left(\frac{.25\sqrt{3}}{2}\right)^2 + \left(\frac{.25e}{2}\right)^2 = 0.23^2$

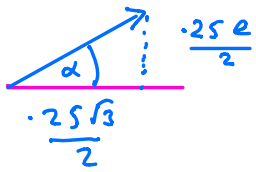
$\frac{3}{64} + \frac{1e^2}{64} = 0.0529$

$3 + e^2 = 3.3856$

$e^2 = 0.3856$

$e = 0.621$

a)



$\alpha = \tan^{-1}\left(\frac{.25 \times 0.621}{.25\sqrt{3}}\right)$

$\alpha = 19.7°$

Moving at angle of 19.7° to first wall.

After 2nd collision

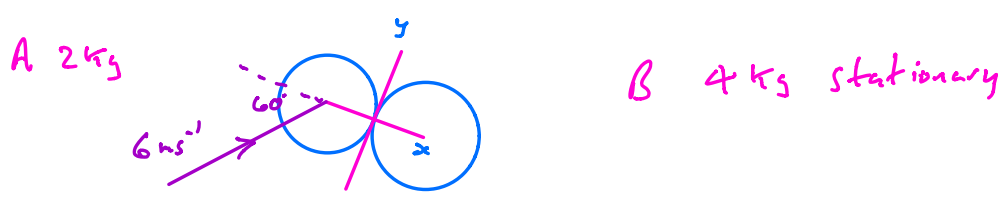
c) $V_y = \frac{.25e}{2}$ $\quad V_x = \frac{.25\sqrt{3}}{2}e$

$$KE = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 0.1 \times \left(\left(\frac{.25}{2} \times 0.621\right)^2 + \left(\frac{.25\sqrt{3} \times 0.621}{2}\right)^2\right)$$

$$= 1.21 \times 10^{-3} \text{ J}$$

A smooth sphere A, of mass 2 kg and moving with speed $6\,\text{m s}^{-1}$ collides obliquely with a smooth sphere B of mass 4 kg. Just before the impact B is stationary and the velocity of A makes an angle of 60° with the lines of centres of the two spheres. The coefficient of restitution between the spheres is $\frac{1}{4}$. Find the magnitudes and directions of the velocities of A and B immediately after the impact.



For A in y-direction ${}_AV_y = 6\sin 60 = 3\sqrt{3}\ ms^{-1}$

For B in y-direction ${}_BV_y = 0$

In x-direction

PCLM $\quad m_A u_A = m_A V_A + m_B V_B$

$$2 \times 3 = 2V_A + 4V_B$$

$$\underline{6 = 2V_A + 4V_B} \quad \Rightarrow \quad 3 = V_A + 2V_B$$

$$V_A = 3 - 2V_B$$

$$\frac{1}{4} = \frac{\text{speed of sep}}{\text{speed of app}} = \frac{V_B - V_A}{3}$$

$$\frac{1}{4} = \frac{V_B - (3 - 2V_B)}{3}$$

$$\frac{3}{4} = 3V_B - 3$$

$$\frac{1}{4} = V_B - 1$$

$$V_B = \frac{5}{4}\ ms^{-1}$$

$$\Rightarrow V_A = 3 - 2\left(\frac{5}{4}\right) = \frac{1}{2}\ ms^{-2}$$