1. A small smooth sphere S of mass m is attached to one end of a light inextensible string of length $2a$. The other end of the string is attached to a fixed point A which is at a distance $a\sqrt{3}$ from a smooth vertical wall. The sphere S hangs at rest in equilibrium. It is then projected horizontally towards the wall with a speed $\sqrt{\left(\frac{37ga}{5}\right)}$.

(a) Show that it strikes the wall with speed $\sqrt{\sqrt{\left(\frac{27ga}{5}\right)}}$

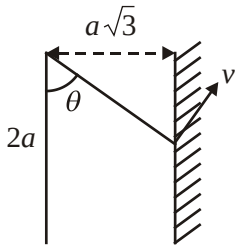
(4)

Given that the loss in kinetic energy due to the impact with the wall is $\frac{3mga}{5}$,

(b) find the coefficient of restitution between S and the wall.

(7)
(Total 11 marks)

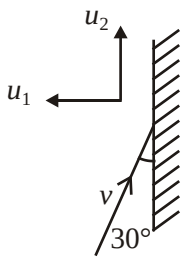
1. (a)



Energy: $\frac{1}{2}m\left(\frac{37ga}{5} - v^2\right) = mg.2a(1 - \cos\theta)$ M1 A1

Using $\theta = \frac{\pi}{3}$ & solve: $\rightarrow \underline{v = \sqrt{\frac{27ga}{5}}}$ M1 A1 4

(b)



Impact: $u_1 = ev\sin 30$ M1 A1

KE loss = $\frac{1}{2}m\,(v^2 \sin^2 30 - e^2v^2 \sin^2 30)$

$\left[+\frac{1}{2}mv^2\cos^2 30 - \frac{1}{2}mu_2{}^2\right] = \frac{3mga}{5}$ M1 A1

[Using $u_2 = v\cos 30$ if necessary & reducing to equation in (m, g, a) e alone]

$\frac{3mga}{5} = \frac{1}{2}m.\frac{27ga}{5}.\frac{1}{4}(1 - e^2)$ A1

Solve for e: $\rightarrow \underline{e = \frac{1}{3}}$ M1 A1 7

[11]

1. This was a challenging question for all but the strongest candidates. Part (a) was accessible although some did not realise it was a circular motion/energy question. Part (b) was not recognised as an oblique impact – on most scripts, there was no attempt to resolve the before and after velocities into components and candidates used v = eu with resultant velocities instead of components perpendicular to the wall.