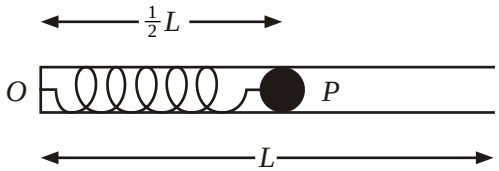
1.



A light elastic spring, of natural length L and modulus of elasticity λ, has a particle P of mass m attached to one end. The other end of the spring is fixed to a point O on the closed end of a fixed smooth hollow tube of length L.

The tube is placed horizontally and P is held inside the tube with $OP = \frac{1}{2}L$, as shown in the diagram above. The particle P is released and passes through the open end of the tube with speed $\sqrt{(2gL)}$.

(a) Show that $\lambda = 8mg$.

(4)

The tube is now fixed vertically and P is held inside the tube with $OP = \frac{1}{2}L$ and P above O.

The particle P is released and passes through the open top of the tube with speed u.

(b) Find u.

(5)

(Total 9 marks)

1. (a) O P EPE stored = $\frac{1}{2}\frac{\lambda}{L}\left(\frac{1}{2}L\right)^2\left(=\frac{\lambda L}{8}\right)$ B1

KE gained = $\frac{1}{2}m\,2gL$ (= mgL) B1

EPE = KE $\Rightarrow$ $\frac{\lambda L}{8}$ = mgL i.e. $\lambda = 8mg$* M1A1cso 4

(b) EPE = GPE + KE M1

P

$\frac{1}{2}\frac{8mg}{L}\left(\frac{1}{2}L\right)^2 = \frac{8mgL}{8} = mg\frac{L}{2} + \frac{1}{2}mu^2$ A1A1

$\frac{mgL}{2} = \frac{m}{2}u^2 \therefore u = \sqrt{gL}$ M1A1 5

[9]

1. There was little here to trouble most candidates and nearly all soon realised that the solutions to both parts came out easily using Conservation of Energy. Even those who may have started to use Hooke's Law and force soon changed their minds and approach. Only rarely did anyone continue to use SHM from $F = ma$ and get it correct. Most incorrectly used a constant thrust and then tried work done = change in energy or they simply quoted results for SHM without proving it was SHM. The few who did loose out in part (b) were those who tried to equate changes in energy rather than energy at a position. It sometimes led to a sign error on the GPE term.