

STEP III, 2003 Q9

- 9 A particle P of mass m is constrained to move on a vertical circle of smooth wire with centre O and of radius a . L is the lowest point of the circle and H the highest and $\angle LOP = \theta$. The particle is attached to H by an elastic string of natural length a and modulus of elasticity αmg , where $\alpha > 1$. Show that, if $\alpha > 2$, there is an equilibrium position with $0 < \theta < \pi$.

Given that $\alpha = 2 + \sqrt{2}$, and that $\theta = \frac{\pi}{2} + \phi$, show that

$$\ddot{\phi} \approx -\frac{g(\sqrt{2} + 1)}{2a} \phi$$

when ϕ is small.

For this value of α , explain briefly what happens to the particle if it is given a small displacement when $\theta = \frac{\pi}{2}$.



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