



STEP III, 2001 Q11

- 11 A uniform cylinder of radius a rotates freely about its axis, which is fixed and horizontal. The moment of inertia of the cylinder about its axis is I . A light string is wrapped around the cylinder and supports a mass m which hangs freely. A particle of mass M is fixed to the surface of the cylinder. The system is held at rest with the particle vertically below the axis of the cylinder, and then released. Find, in terms of I , a , M , m , g and θ , the angular velocity of the cylinder when it has rotated through angle θ .

Show that the cylinder will rotate without coming to a halt if $m/M > \sin \alpha$, where α satisfies $\alpha = \tan^{-1} \frac{1}{2} \alpha$ and $0 < \alpha < \pi$.



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