

STEP II, 2012 Q10

- 10 A hollow circular cylinder of internal radius r is held fixed with its axis horizontal. A uniform rod of length $2a$ (where $a < r$) rests in equilibrium inside the cylinder inclined at an angle of θ to the horizontal, where $\theta \neq 0$. The vertical plane containing the rod is perpendicular to the axis of the cylinder. The coefficient of friction between the cylinder and each end of the rod is μ , where $\mu > 0$.

Show that, if the rod is on the point of slipping, then the normal reactions R_1 and R_2 of the lower and higher ends of the rod, respectively, on the cylinder are related by

$$\mu(R_1 + R_2) = (R_1 - R_2) \tan \phi$$

where ϕ is the angle between the rod and the radius to an end of the rod.

Show further that

$$\tan \theta = \frac{\mu r^2}{r^2 - a^2(1 + \mu^2)}.$$

Deduce that $\lambda < \phi$, where $\tan \lambda = \mu$.



NextStepMaths.com

To view mark schemes, fully worked solutions and examiner's comments, and for more details about tutoring and other services offered, go to

NextStepMaths.com