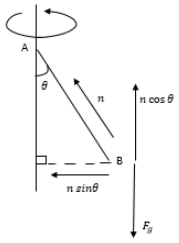
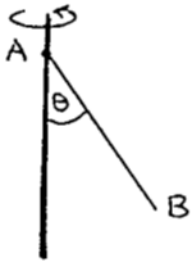


2.

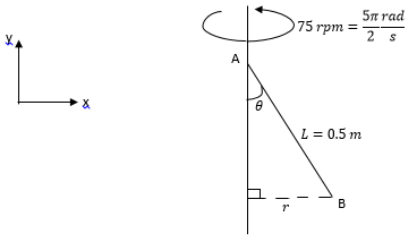


Rod AB has length 0.5 m, and is attached by a frictionless pin at A to a vertical shaft which rotates at 75 rpm.

(a) At what angle ϑ to the vertical will the rod hang in the steady state?

(b) If the rod is hanging vertically ($\vartheta = 0$) when the rotation suddenly begins, what will be the speed of the rod's centre when ϑ has increased to 30^0?

2.



$L = 0.5$

$r = L\sin\theta$

$$\omega = 75\frac{rotations}{minute} \times \frac{2\pi\ radians}{rotation} \times \frac{1\ minute}{60\ seconds} = \frac{5\pi}{2}\frac{rad}{s}$$

$$s = length\ of\ of\ arc = \frac{\theta\ rad}{2\pi\ rad}(2\pi r)$$

$$v = \frac{\omega}{2\pi\ rad}(2\pi r) = \frac{\omega}{rad}(L\sin\theta) = \left(\frac{5\pi}{2}\right)L\sin\theta$$

$$F_y = 0 = n\cos\theta - mg \rightarrow n = \frac{mg}{\cos\theta}$$

a) $\tau = LF_x$

$\tau = L(n\sin\theta)$

$\frac{1}{2}I\omega^2 = L\left(\frac{mg}{\cos\theta}\right)\sin\theta$

$\frac{1}{2}\left(\frac{1}{2}mL^2\right)\omega^2 = L\left(\frac{mg}{\cos\theta}\right)\sin\theta$

$\frac{1}{4}L\left(\frac{5\pi}{2}\right)^2 = \left(\frac{g}{\cos\theta}\right)\sin\theta$

$\frac{1}{4}\left(\frac{1}{2}\right)\left(\frac{25\pi^2}{4}\right) = g\frac{\sin\theta}{\cos\theta}$

$\tan\theta = \frac{25\pi^2}{32g}$

$\theta = 38.17°$

b) $v = \left(\frac{5\pi}{2}\right)L\ sin\ \theta$

$= \left(\frac{5\pi}{2}\right)\left(\frac{1}{4}\right)\sin(30)$

$= 0.982\ m/s$