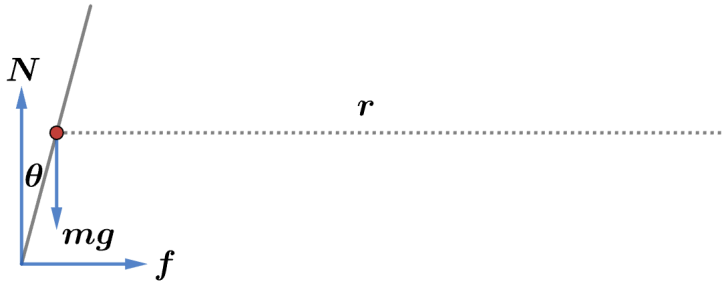
2014 F=ma Exam: Problem 5

Kevin S. Huang



Applying Newton's 2nd law, we have in the vertical direction

$$N = mg$$

Since friction provides the centripetal acceleration,

$$f = \frac{mv^2}{r}$$

We choose the CM as the pivot point and balance torques. The weight of the unicyclist acts at the CM so doesn't contribute to the torque. If the unicyclist has length l then

$$N\left(\frac{l}{2}\sin\theta\right) = f\left(\frac{l}{2}\cos\theta\right)$$

Solving for θ,

$$\tan\theta = \frac{f}{N} = \frac{mv^2/r}{mg} = \frac{v^2}{gr} = \frac{(10\,\text{m/s})^2}{(10\,\text{m/s}^2)(30\,\text{m})} = \frac{1}{3}$$

$$\theta = \arctan\left(\frac{1}{3}\right) = 18.4^\circ$$

so the answer is $\boxed{\text{C}}$.