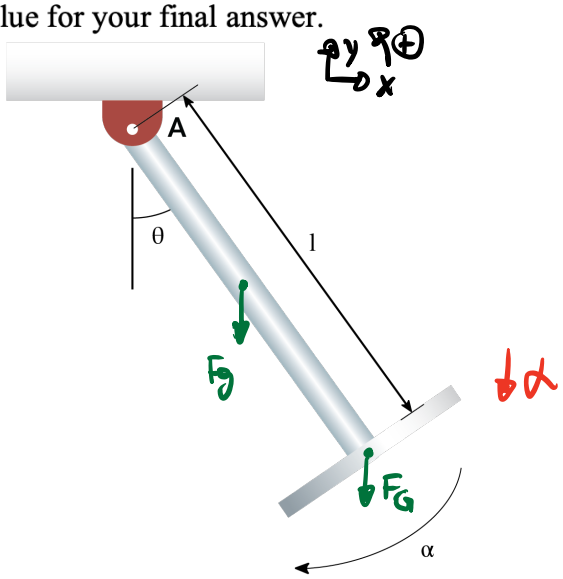
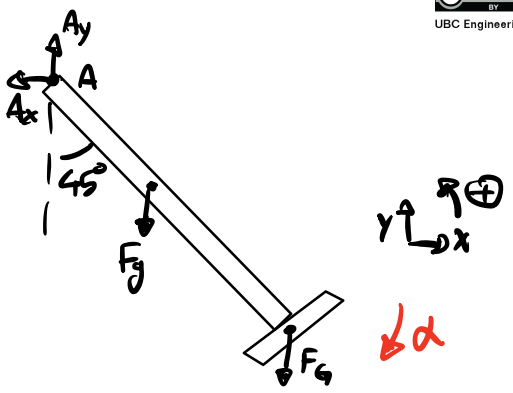
A hardworking engineer is developing a playground ride for her kid. If she determines that the maximum acceleration of an empty ride in the instant shown should not exceed $5\ rad/s^2$ due to safety reasons, what should be the length of the rod on which a $1kg$ seat is attached? The seat can be modelled as a thin disk with radius $r = 0.3m$ and the rod, no matter the length, has a mass of $m = 0.6kg$.
The angle in the instant shown is $\theta = 45\ deg$.
Choose the most realistic value for your final answer.



① Diagram FBD



$$\Sigma M_A = I\alpha \Rightarrow I_A\alpha = -\frac{\ell}{2}\sin\theta\, m_{rod}\, g - \ell \sin\theta\, m_{disk}\, g$$

$$I_A = \frac{1}{3}m\ell^2 + \frac{1}{4}mr^2 + md^2 = \frac{1}{3}(0.6\,kg)\,\ell^2 + \frac{1}{4}(1\,kg)(0.3m)^2 + (1\,kg)\,\ell^2$$

$$\alpha\left[\frac{1}{3}(0.6\,kg)\,\ell^2 + \frac{1}{4}(1\,kg)(0.3\,m)^2 + (1\,kg)\,\ell^2\right] = -\frac{\ell}{2}\sin(45^\circ)(0.6\,kg)(9.81\,m/s^2)$$
$$- \ell\sin(45^\circ)(1\,kg)(9.81\,m/s^2)$$

$\curvearrowright$ plug in $\alpha = 5\ rad/s^2$

$$\curvearrowright \quad -6\ell^2 - 0.1125 + 9.0177\ell = 0$$

$$\curvearrowright \quad \ell = 0.0126\,m \text{ or } \ell = 1.49\,m$$

$$\boxed{\ell = 1.49\ m}$$