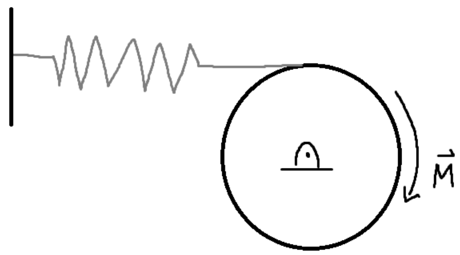
22-R-WE-TW-23



A spring with spring constant 120 N/m is connected to a disk with a mass 15 kg, radius $r = 1$ m, and radius of gyration of 0.6 m. A moment of $\vec{M} = -40\hat{k}$ N $\cdot$ m is required to keep the disk in equilibrium. If the moment is suddenly released, what is the maximum angular velocity the disk will experience?

Solution:

$$\sum M_O : \ \vec{M} + \vec{r} \times \vec{F}_s = 0$$

$$\begin{aligned}
F_s &= kx \\
M &= rF = rkx \\
x &= \frac{M}{rk} = \frac{40}{(1)(120)} = 0.33 \text{ [m]} \\
U_s &= T_{rot} \\
\frac{1}{2}kx^2 &= \frac{1}{2}I_O\omega^2 \\
\omega^2 &= \frac{kx^2}{I_O} \\
I_O &= mk^2 = (15)(0.6)^2 = 5.4 \text{ [kg} \cdot \text{m}^2\text{]} \\
\vec{\omega} &= x\sqrt{\frac{k}{I_O}}\hat{k} = (0.33)\sqrt{\frac{120}{5.4}}\hat{k} = 1.57\hat{k} \text{ [rad/s]}
\end{aligned}$$