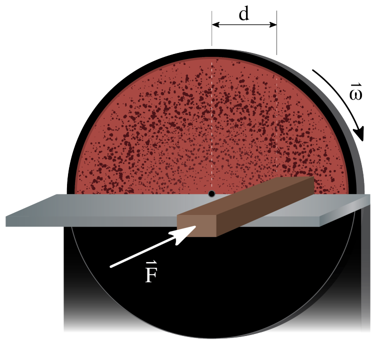
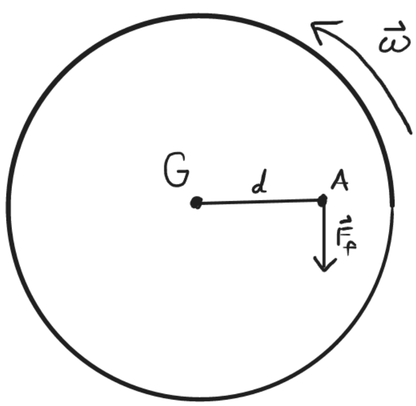
22-R-IM-TW-35



A circular industrial disc sander of radius with a moment of inertia about its center of rotation of $0.5\ \text{kg}\cdot\text{m}^2$ is rotating at a speed of 1100 revolutions per minute just after being disconnected from power. A block of wood is pushed against the sander with force given by the equation $F(t) = 16\sqrt{t}$ N at a distance of 5 cm from the center of the sander in order to slow down the rotation. How long does it take the sander to completely stop spinning? (Take the coefficient of kinetic friction between the wood and sanding disc to be $\mu_k = 0.8$)

Solution:



Note that the force applied will be matched with an equal and opposite normal force from the disc. $|\vec{F}(t)| = |\vec{N}(t)|$

$$\omega = \frac{(2\pi)(1100)}{60} = 115.2\ [\text{rad/s}]$$

$$H_{G,2} - H_{G,1} = \sum \int_0^{t_2} M(\tau)d\tau$$

$$H_{G,2} = 0$$

$$-\vec{H}_{G,1} = -I_G\vec{\omega} = \int_0^{t_2} (\vec{r}_{F/G} \times \vec{F}_f(\tau))d\tau$$

$$I_G\omega(\hat{k}) = \int_0^{t_2} d\mu_k N(\tau)d\tau(\hat{k}) = d\mu_k \int_0^{t_2} 16\sqrt{\tau}d\tau(\hat{k})$$

$$
\begin{aligned}
I_G\omega &= \frac{32}{3} d\mu_k t^{3/2} \\
t &= \left(\frac{3I_G\omega}{32d\mu_k}\right)^{2/3} = \left(\frac{3(0.5)(115.2)}{32(0.05)(0.8)}\right)^{2/3} = 26.3 \text{ [s]}
\end{aligned}
$$