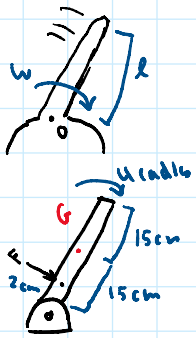
20-R-IM-DK-5

July 6, 2020 9:21 AM

Beginner Principle of Impulse and Momentum Video

Inspiration: None



A happy dog's wagging tail can be modelled as a slender rod with constant density and a pin joint. If the tail has a mass of $m = 1\text{kg}$ and length $l = 30\text{ cm}$, determine the angular momentum of the tail about point O at the instant the dog is wagging at $\omega = 4\text{ rad/s}$.

The dog is exerting a constant force in its muscles to create the moment to wag its tail. If it can be modelled that the force is applied 13 cm away from its center of gravity towards point O, determine the force exerted to reach an angular velocity of $\omega = 4$ rad/s in 2 seconds if the tail started at rest.

$$\vec{H}_O = I_O \vec{\omega} = \left[\frac{1}{12}ml^2 + m\left(\frac{1}{2}l\right)^2\right]\omega = \left[\frac{1}{3}ml^2\right]\omega$$

$$= \frac{1}{3}(1)(0.3)^2(4) = 0.12$$

$$I_O\omega_1 + \sum \int_{t_1}^{t_2} M_O\,dt = I_O\omega_2 \qquad \omega_1 = 0 \text{ Starts at rest}$$

$$0 + \int_0^2 M_O\,dt = 0.12 \qquad M_O(2) = 0.12 \qquad M_O = 0.06$$

$$M = rF \qquad 0.06 = 0.02F \qquad \boxed{F = 3N}$$