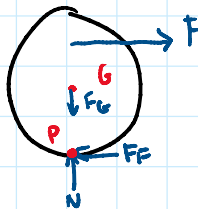


Intermediate Principle of Impulse and Momentum

Inspiration: Hibbeler pg. 527

A 200 g yo-yo is being pulled along the ground where it rolls without slipping. The string is wrapped around the central hub of the yo-yo and is subjected to a force $F = (t^2 + 2) \text{ N}$, where t is in seconds. If the yo-yo can be treated as two outer disks with a radius of $r_2 = 4 \text{ cm}$ and an inner disk (central hub) with a radius of $r_1 = 3 \text{ cm}$, each with the same mass, determine the yo-yo's angular velocity after 5 seconds if it initially starts at rest. Assume the string has negligible mass.



3 disks with total mass of 200g, each with equal mass
 $m_{\text{disk}} = \frac{200}{3} = 66.\overline{6} \text{ g} = \frac{1}{15} \text{ kg}$

$$I_G = \frac{1}{2} \left(\frac{1}{15} \right) \left(\frac{4}{100} \right)^2 \times 2 + \frac{1}{2} \left(\frac{1}{15} \right) \left(\frac{3}{100} \right)^2$$

$$= \frac{41}{300000}$$

F_f will be a variable force because it is rolling without slipping and it is an unknown. It creates a moment about G so to "ignore" it, take the moment about where the yo-yo contacts the ground, point P

$$I_P \omega_1 + \sum M_P dt = I_P \omega_2 = (I_G + m d^2) \omega_2$$

$$0 + \int_0^5 t^2 + 2 dt \left(\frac{4}{100} + \frac{3}{100} \right) = \left[\frac{41}{300000} + \left(\frac{200}{1000} \right) \left(\frac{4}{100} \right)^2 \right] \omega_2$$

$$\left[\frac{1}{3} t^3 + 2t \right]_0^5 \left(\frac{7}{100} \right) = 0.0033\overline{3} \omega_2$$

$$\omega_2 = 1063.916064$$

very fast so should change force and time in code

$$t = 0.1$$