

**Force Acceleration III – Problem 2**

The lawn roller has a mass of 80 kg and a radius of gyration of  $k_G = 0.175$  m. If it is pushed forward with a force of 200 N when the handle is at  $45^\circ$ , determine its angular acceleration and acceleration of G. The coefficients of static and kinetic friction between the ground and the roller are  $\mu_s = 0.12$  and  $\mu_k = 0.1$ , respectively. Check any assumptions you make.

CLASSIFY MOTION  
 GPM

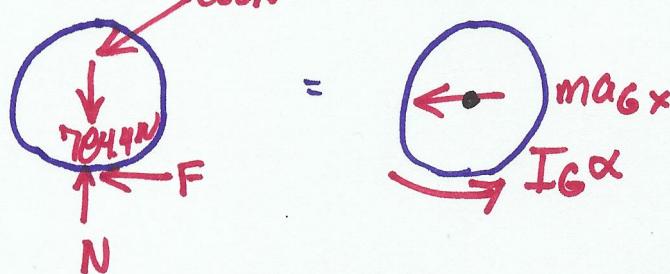
PROPERTIES

$$m = 80 \text{ kg}$$

$$w = 784.8 \text{ N}$$

$$I_G = 80(0.175)^2 = 2.45 \text{ kg-m}^2$$

$$\text{FBD} \quad 200\text{N} = K D$$



$$x: \rightarrow -.707(200) - F = -80 \text{ mag}_x$$

$$\text{ASSUME NO SLIP} \quad \therefore a_{Gx} = \alpha r = 0.2\alpha$$

$$F - 16\alpha = -141 \quad \text{I}$$

$$y: \uparrow \quad -784.4 - .707(200) + N = 0 \quad N = 926.2 \text{ N} \uparrow$$

$$m_G: \rightarrow 0.2F = -I_G\alpha = -2.45\alpha \quad \text{II} \quad 0.2F + 2.45\alpha = 0$$

SOLVE I + II

$$\begin{bmatrix} 1 & -16 \\ 0.2 & 2.45 \end{bmatrix} \begin{Bmatrix} F \\ \alpha \end{Bmatrix} = \begin{Bmatrix} -141 \\ 0 \end{Bmatrix} \Rightarrow \begin{aligned} F &= -61 \text{ N} \\ \alpha &= 4.99 \text{ rps}^2 \end{aligned}$$

CHECK NO SLIP ASSUMPTION

$$F_{max} = \mu_s N = 0.12(926.2) = 111 > 61 \quad \therefore \text{NO SLIP!}$$

$$\underline{\underline{a_{Gx} = \alpha r = 0.2(4.99) = 0.998 \text{ m/s}^2}}$$

