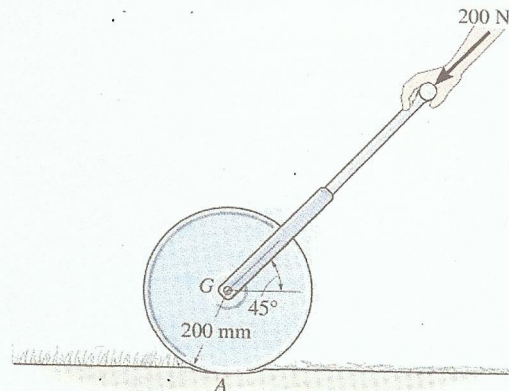


Force Acceleration III – Problem 2

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° , 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

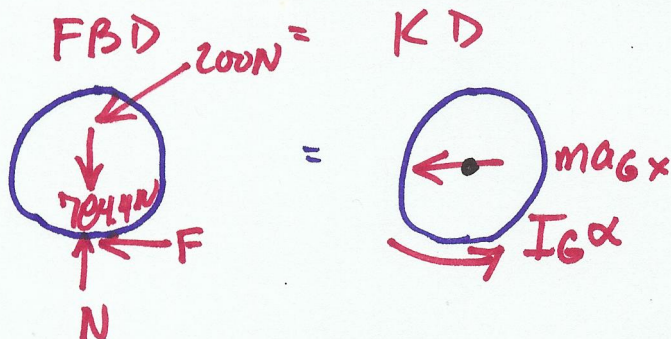
GPM

PROPERTIES

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

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

$$I_G = 80(0.175)^2 = 2.45 \text{ kgm}^2$$



$$\begin{aligned} \sum F_x = 0: & \quad -784.8 - 200 \cos 45^\circ - F = -80 a_{Gx} \\ & \quad \text{ASSUME NO SLIP} \quad \therefore a_{Gx} = \alpha r = 0.2 \alpha \\ & \quad \rightarrow F - 16 \alpha = -141 \quad \text{I} \end{aligned}$$

$$\sum F_y = 0: \quad -784.8 - 200 \sin 45^\circ + N = 0 \quad N = 926.2 \text{ N} \uparrow$$

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

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

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

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