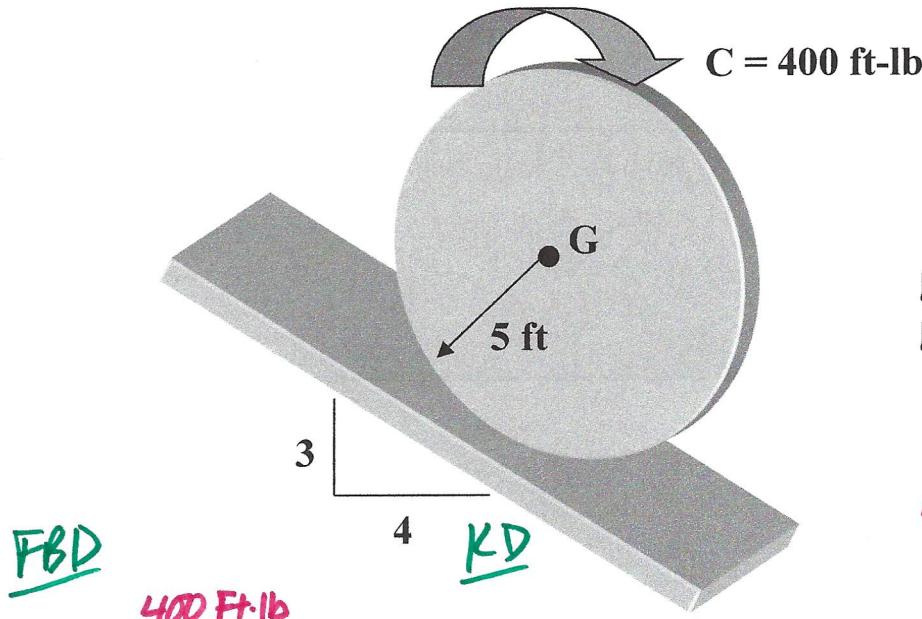


### Force Acceleration I – Problem 4

A drum having a radius of 5 ft and weighing 161 lbs has a radius of gyration with respect to an axis perpendicular to the paper through the center of mass, G, of 2 ft. A couple of magnitude C = 400 ft-lbs is applied as shown.

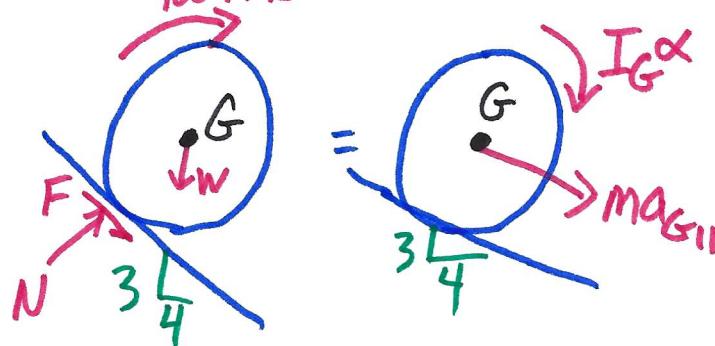
- Determine the acceleration of the center of mass, G.
- Determine the magnitude and direction of the friction force.

CLASSIFY MOTION  
GPM



FBD

KD



$$I \rightarrow \sum F_{\parallel} = ma_{G\parallel} \Rightarrow \frac{3}{5}(161) + F = 5(5\alpha)$$

$$II \nearrow \sum F_{\perp} = ma_{G\perp} \Rightarrow N - \frac{4}{5}(161) = 0 \quad N = 128.8 \text{ lb}$$

$$III \rightarrow \sum M_G = I_G \alpha \Rightarrow 400 - 5F = 20\alpha$$

SOLVE I + III

$$\alpha = 6.09 \text{ rps}^2 \quad F = 55.4 \text{ lbs}$$

PROPERTIES

$$W = 161 \text{ lbs}$$

$$m = \frac{161}{32.2} = 5 \text{ slug}$$

$$\mu_s = 0.3$$

$$\mu_k = 0.2$$

$$I_G = MK^2 = 5(2)^2 = 20 \text{ slug}\cdot\text{ft}^2$$

ASSUME NO SLIP WHEEL

$$a_{G\parallel} = \alpha r = 5\alpha$$

Force Acceleration I – Problem 4 continued

BUT WAIT!

$$\text{IF NO SUP } F = M_s N = 0.3(120.0) = 36.0 < 55.4$$

$\therefore$  NO SLIP WHEEL ASSUMPTION NO GOOD, DRUM SLIPS

THEREFORE  $F = M_k N$  AND  $a_{GII} \neq \alpha r$

$$F = 0.2(120.0) = 24.0$$

EQN I AGAIN

$$\Rightarrow \sum F_{II} = ma_{GII} \Rightarrow \frac{3}{5}(161) + 24.0 = 5a_{GII}$$

$$a_{GII} = 24.5 \text{ ft/s}^2$$

CAN SOLVE BY EM OTHER THAN G! TRY POC WITH GROUND

$$\Rightarrow \sum M_{POC} = \sum M_{IC} \Rightarrow 400 + \frac{3}{5}(161)5 = 200\alpha + (5(5\alpha))5$$

$$\Rightarrow \sum F_{II} = Ma_{GII} \Rightarrow \frac{3}{5}(161) + F = 5(5\alpha)$$

$$\text{SOLVE } \alpha = 6.09 \text{ rps}^2 \Rightarrow F = 55.4 \text{ lbs}$$

SAME AS BEFORE