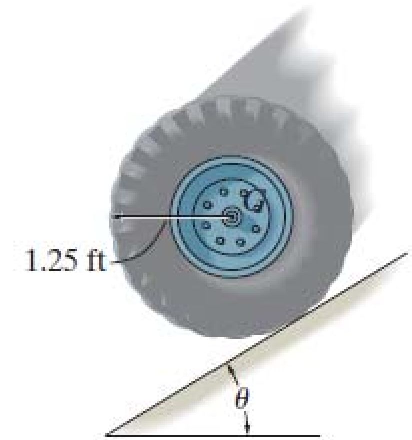
17–94.

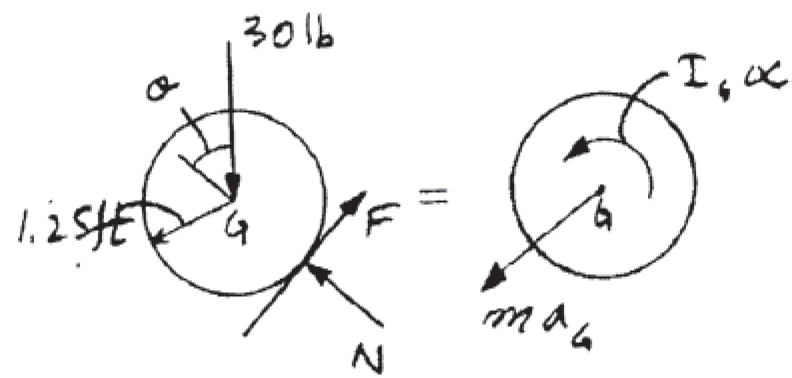
The tire has a weight of 30 lb and a radius of gyration of $k_G = 0.6$ ft. If the coefficients of static and kinetic friction between the wheel and the plane are $\mu_s = 0.2$ and $\mu_k = 0.15$, determine the tire's angular acceleration as it rolls down the incline. Set $\theta = 12°$.



$$+\swarrow \Sigma F_x = m(a_G)_x; \qquad 30 \sin 12° - F = \left(\frac{30}{32.2}\right) a_G$$

$$+\nwarrow \Sigma F_y = m(a_G)_y; \qquad N - 30 \cos 12° = 0$$

$$\circlearrowleft + \Sigma M_G = I_G\,\alpha; \qquad F(1.25) = \left[\left(\frac{30}{32.2}\right)(0.6)^2\right]\alpha$$



Assume the wheel does not slip.

$$a_G = (1.25)\alpha$$

Parameters: $W = 30 \quad theta = 12 \cdot deg \quad r = 1.5 \quad k_G = 0.8 \quad gc = 32.2 \quad mu_s = 0.25$

with guesses: $F = 0 \quad N = 0 \quad a_G = 0 \quad alpha = 0$

$$Given \qquad W \cdot sin(theta) - F = \frac{W}{gc} \cdot a_G \qquad N - W \cdot cos(theta) = 0$$

$$F \cdot r = \frac{W}{gc} \cdot k_G{}^2 \cdot alpha \qquad a_G = r \cdot alpha$$

$$Find\left(F, N, a_G, alpha\right)^T = (\,1.381 \quad 29.344 \quad 5.212 \quad 3.475\,)$$

Find the value of theta where the wheek is fixin' to slip (impending slip).

Given $W \cdot \sin(theta) - F = \frac{W}{gc} \cdot a_G$ $N - W \cdot \cos(theta) = 0$

$F \cdot r = \frac{W}{gc} \cdot k_G^2 \cdot alpha$ $a_G = r \cdot alpha$ $F = mu_s \cdot N$

$$\begin{pmatrix} F \\ N \\ a_G \\ alpha \\ theta \end{pmatrix} = Find(F, N, a_G, alpha, theta)$$

$$\begin{pmatrix} F \\ N \\ a_G \\ alpha \\ theta \end{pmatrix} = \begin{pmatrix} 4.973 \\ 19.892 \\ 18.766 \\ 12.51 \\ 0.846 \end{pmatrix}$$

$theta = 48.465 \cdot deg$

$F = 4.973$ $mu_s \cdot N = 4.973$

Define a function for plotting

$$\text{Given} \qquad 30\cdot sin(theta) - F = \frac{W}{gc}\cdot a_G \qquad N - W\cdot cos(theta) = 0$$

$$F\cdot r = \frac{W}{gc}\cdot k_G^{\,2}\cdot alpha \qquad a_G = r\cdot alpha \qquad F = mu_s\cdot N$$

$$roll\left(mu_s\right) = Find\left(F, N, a_G, alpha, theta\right)$$

$$roll(0.2) = \begin{pmatrix} 4.453 \\ 22.264 \\ 16.803 \\ 11.202 \\ 0.735 \end{pmatrix}$$