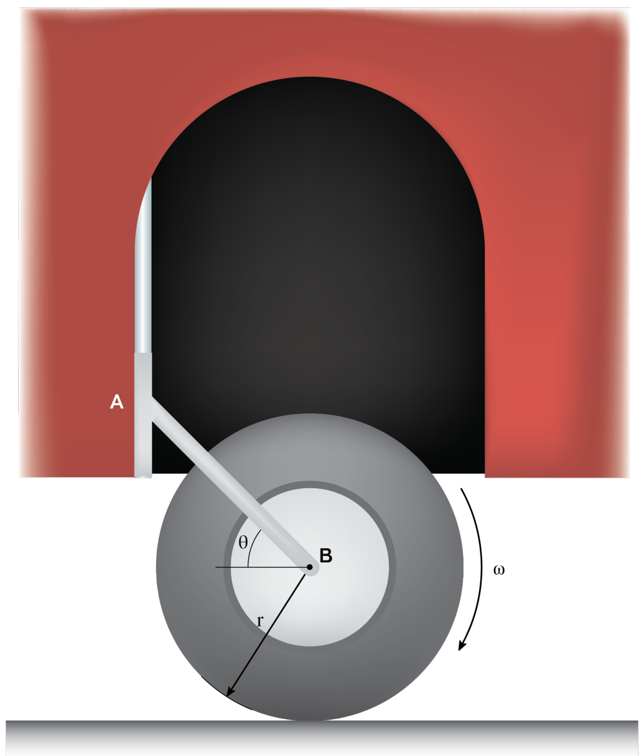
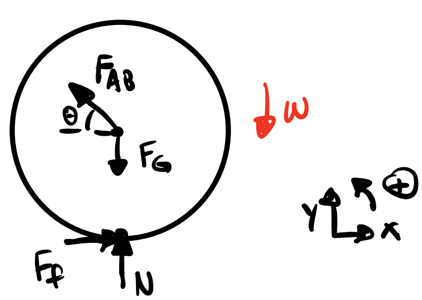
Students are creating a miniature all-terrain vehicle for a competition. An idea was proposed for an additional wheel which could be lowered and raised to dislodge the vehicle if it ever got stuck on jagged rocks. They decide to apply minimum constraint design to their prototype, resulting in a singular linkage arm attached to a wheel with radius $r = 0.15m$ at an angle of $\theta = 30\ deg$. The wheel has a mass of $m = 5kg$ and a radius of gyration $k_B = 0.2m$. If the students rev the wheel such that it initially spins with $\omega = 30\ rad/s$, determine the reaction force exerted on the linkage AB. What is the time required for the wheel to stop rotating? The coefficient of kinetic friction is given as $\mu_K = 0.4$. Assume the linkage arm is securely locked in once it is lowered and neglect the mass of the linkage arm.






① Diagram

FBD



$$\sum F_x = 0 \Rightarrow F_f - F_{AB}\cos\theta = 0 \qquad (1)$$

$$\sum F_y = 0 \Rightarrow F_{AB}\sin\theta - F_G + N = 0 \qquad (2)$$

$$\sum M_B = I\alpha \Rightarrow F_f r = I_B \alpha \qquad (3)$$

$$I_B = m k_B^2 = (5\,kg)(0.2\,m)^2 = 0.2\,kgm^2$$

$$(4) \quad F_f = \mu_k N$$

| |
|---|
| $F_{AB} = 18.4\,N$ |
| $N = 39.8\,N$ |

$F_f = 0.4\,N$

$\alpha = 11.96\,rad/s^2$

$$\omega = \omega_0 + \alpha t$$

$\omega = 0\,rad/s$

$\omega_0 = 30\,rad/s$

$$(0\,rad/s) = (30\,rad/s) + (-11.96\,rad/s^2)\,t$$

$\Rightarrow$ **$t = 2.5\,sec$**