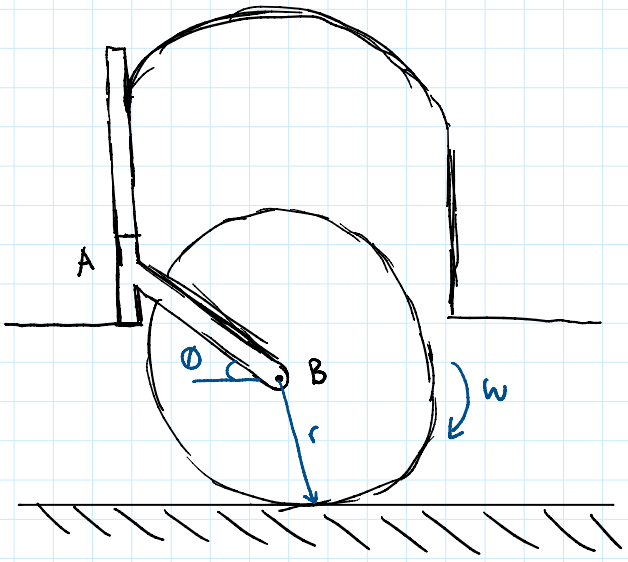
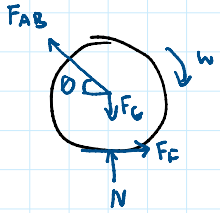
20-R-KIN-DK-26

July 22, 2020 9:38 AM

20-R-KIN-DK-26 Intermediate Rotation (RBK)

Inspiration: 17-75 Hibbeler





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 = 0.15 m*** at an angle of ***theta = 30 degrees***. The wheel has a mass of ***m = 5 kg*** and a radius of gyration ***k_B = 0.2 m***. If the students rev the wheel such that it initially spins with ***omega = 30 rad/s***, determine the reaction force exerted on the link 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.

$I_B = mk_B^2 = 5(0.2)^2 = 0.2$

$\Sigma F_x: ma_{Gx} = 0 = F_F - F_{AB}\cos\theta$

$\Sigma F_y: ma_{Gy} = 0 = F_{AB}\sin\theta - F_G + N$

$\Sigma M_B: I_B\alpha = F_F r$

$0.4N = F_{AB}\cos 30$ $\quad N = \frac{F_{AB}\cos 30}{0.4}$

$N = F_G - F_{AB}\sin 30$ $\quad \frac{F_{AB}\cos 30}{0.4} = 5(9.81) - F_{AB}\sin 30$

$F_{AB} = 16.40481\ N$ $\quad N = 39.447593\ N$

$0.2\alpha = 0.4N(0.15)$ $\quad \alpha = 11.95427\ rad/s^2$

ω goes clockwise, α goes counterclockwise

$\omega = \omega_0 + \alpha t$ $\quad 0 = 30 + (-11.95427)t$

$t = 2.50956\ s$