Rigid Body Kinetics - Rotation about a fixed axis

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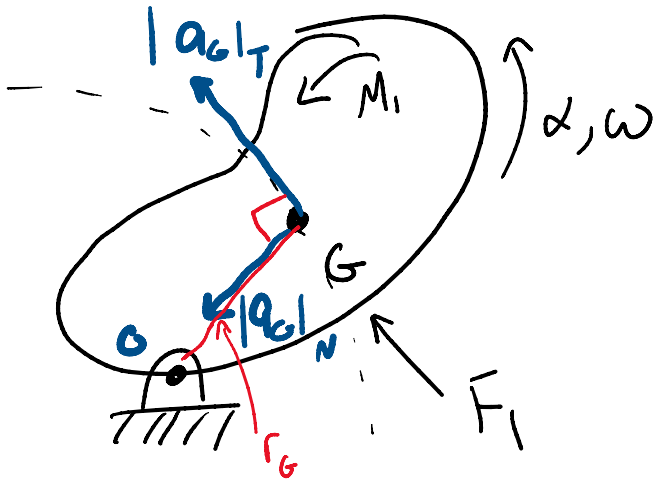

$$(a_G)_T = \alpha r_G$$

$$(a_G)_N = \omega^2 r_G$$

Remember to include reaction forces

Motion of a point on a curved path (N-T)

$$\Sigma F_N = m(a_G)_N = m\omega^2 r_G$$

$$\Sigma F_T = m(a_G)_T = m\alpha r_G$$

$$\Sigma M_G = I_G \alpha \quad \text{or} \quad \Sigma M_o = I_o \alpha$$

$$I_o = I_G + md^2$$

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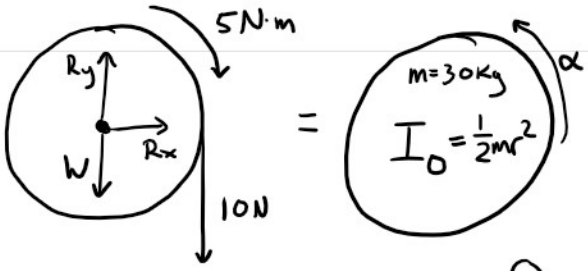

$\omega_o = 0$

$\omega_f = 20\ rad/s$

$I_o = \frac{1}{2}(30)(0.2)^2 = 0.6\ kgm^2$

$\Sigma F_x = ma_x$

$Rx = 0$

$\Sigma F_y = m\cancel{a_y}^{0}$

$Ry - W - 10 = 0$

$Ry - (30)(9.81) - 10 = 0$

$Ry = 304N$

$\circlearrowleft +) \Sigma M_o = I_o\alpha$

$-5 - (10)(.2) = 0.6\alpha$

$\alpha = -11.67\ rad/s^2$

$11.67\ rad/s^2 \curvearrowright$

$\omega_o = 0$

$\omega_f = 20\ rad/s$

$\alpha = -11.67\ rad/s^2$

$\theta_f = ?$

$\theta_o = 0$

Kinematics

$\omega_f^2 = \omega_o^2 + 2\alpha(\theta_f - \theta_o)$

$20^2 = 0^2 + 2(-11.67)(\theta_f)$

$\theta_f = -17.14\ rad$

$(-17.14\ \cancel{rad})\left(\frac{1\ rev}{2\pi\ \cancel{rad}}\right)$

$\theta_f = -2.73\ revs$

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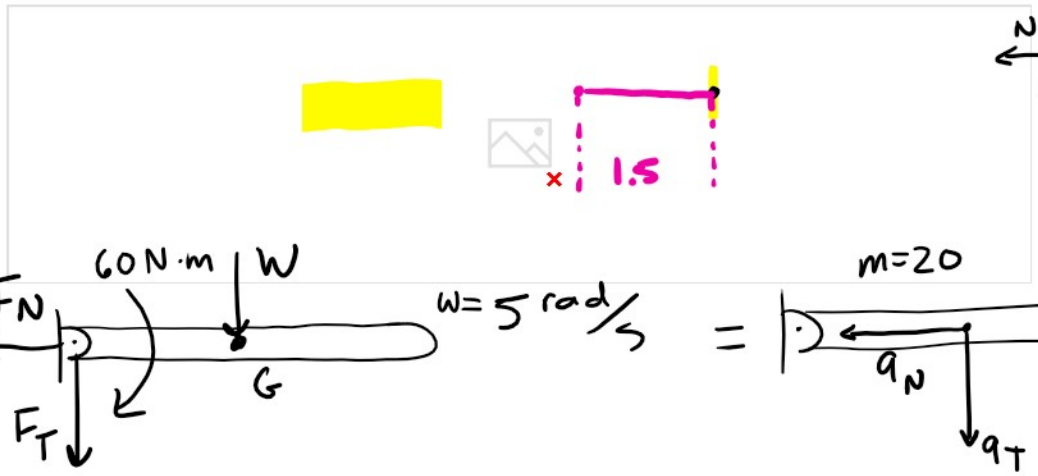

$\overset{+}{\leftarrow} \Sigma F_N = m(a_G)_N = mw^2 r_G$

$F_N = (20)(5)^2(1.5)$

$= 750\,N$

$\overset{+}{\circlearrowright} \Sigma M_G = I_G \alpha$

$60 + (F_T)(1.5) = \frac{1}{12}(20)(3)^2\alpha$

15

$\Sigma F_T = m(a_G)_T = m\alpha r_G$

$F_T + (20)(9.81) = (20)\alpha(1.5)$

$F_T = 20\alpha(1.5) - 196.2$

$= 20(5.9)(1.5) - 196.2$

$= -19.2\,N$

$= 19.2\,N \uparrow$

$60 - 1.5[(20\alpha)(1.5) - 196.2] = 15\alpha$

$60 - 1.5[30\alpha - 196.2] = 15\alpha$

$60 - 45\alpha + 294.3 = 15\alpha$

$354.3 = 60\alpha$

$\alpha = 5.9\ rad/s^2$

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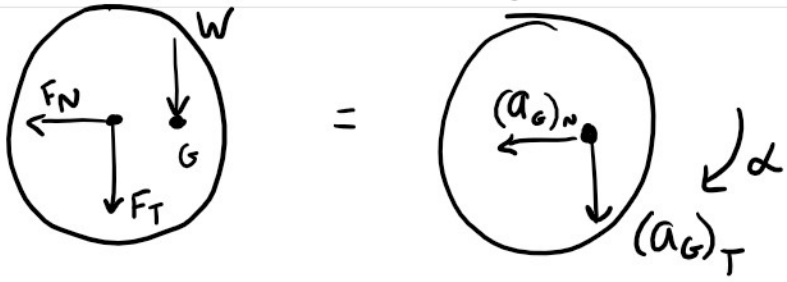
$$K = \sqrt{\frac{I}{m}}$$

$\omega = 8$ rad/s

N, T

$m = \frac{50}{32.2}$



$$I_G = mK^2 = \left(\frac{50}{32.2}\right)(0.6)^2 = 0.559 \text{ slug ft}^2$$

$$\Sigma F_N = m(a_G)_N = m\omega^2 r_G$$

$$F_N = \left(\frac{50}{32.2}\right)(8)^2(0.5)$$

$$= 49.6 \text{ lb} \leftarrow$$

$$+\downarrow \Sigma F_T = m(a_G)_T = m\alpha r_G$$

$$F_T + 50 = \left(\frac{50}{32.2}\right)\alpha(0.5) \quad (1)$$

$$-1.118\alpha + 50 = 0.776\alpha$$

$$50 = 1.89\alpha$$

$$\alpha = 26.4 \text{ rad/s}^2$$

$$\circlearrowleft \Sigma M_G = I_G\alpha$$

$$(-F_T)(0.5) = (0.559)(\alpha) \quad (2)$$

$$F_T = -1.118\alpha$$

$$= -1.118(26.4)$$

$$= -29.5 \text{ N}$$