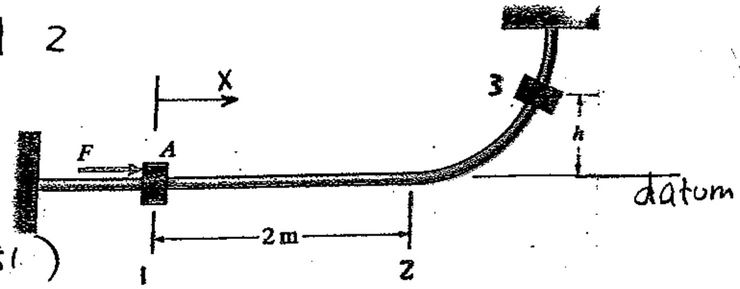
A 12-kg collar A is at rest in the position shown, but is then subjected to a tangential force $F = 24 + 12x^2$ (N). The kinetic coefficient of friction between the collar and rod, $\mu_k = 0.3$. Assume that the rod is smooth after the 2 m distance as it enters the circular portion and determine a) the velocity of the collar after it has traveled 2 meters, and b) the maximum height h the collar will reach.

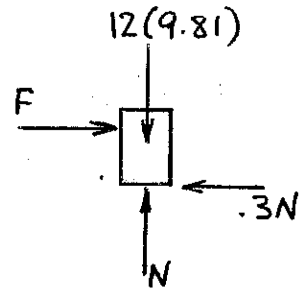
The force F stops at point 2



$$\overset{+}{\rightarrow}\ \sum F_x = F - .3N = ma$$

$$= 24 + 12x^2 - .3(12)(9.81)$$

$$= 12\, v \frac{dv}{dx}$$



$$\int_0^2 (-11.316 + 12x^2)\, dx = 12\int_0^v v\, dv$$

$$-11.316(2) + \frac{12(2)^3}{3} = \frac{12 v^2}{2}$$

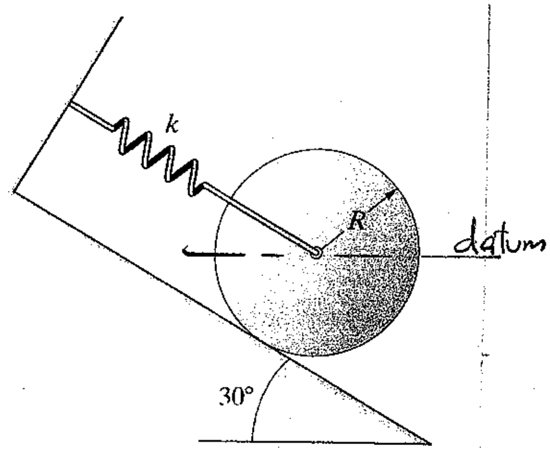
$$V = 1.25 \text{ m/sec} \qquad v^2 = 1.561 \text{ m}^2/\text{sec}^2$$

$$T_2 + V_2 + U_{1-2} = T_3 + V_3$$

$$\frac{1}{2}(12)(1.561) + 0 + 0 = 0 + 12(9.81)h$$

$$h = 0.0795 \text{ m}$$

The disk shown weighs 12 lbs and its radius R = 6 in. The spring constant k = 3 lb/ft. The disk is released from rest with the spring unstretched and rolls without slipping. Determine the magnitude of the velocity of the center of the disk when it has moved 2 ft from its original position.



Using energy method

$$T = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}mv^2 + \frac{1}{2}\left[\frac{1}{2}mR^2\right]\left(\frac{v^2}{R^2}\right)$$

$$= \frac{3}{4}mv^2$$

$$T_1 + V_1 + U_{1-2} = T_2 + V_2$$

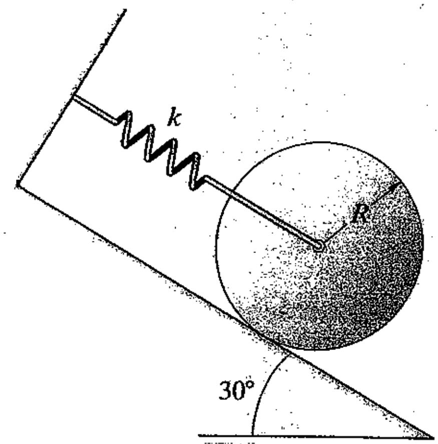
$$0 + 0 + 0 = \frac{3}{4}mv^2 + \frac{1}{2}kx^2 - mg\sin 30^\circ(2)$$

$$0 = \frac{3}{4}\left(\frac{12}{32.17}\right)v^2 + \frac{1}{2}(3)(2)^2 - 12(.5)(2)$$

$$v^2 = 21.44$$

$$v = \overrightarrow{4.63\ ft/sec}$$

The disk shown weighs 12 lbs and its radius R = 6 in. The spring constant k = 3 lb/ft. The disk is released from rest with the spring unstretched and rolls without slipping. Determine the magnitude of the velocity of the center of the disk when it has moved 2 ft from its original position.

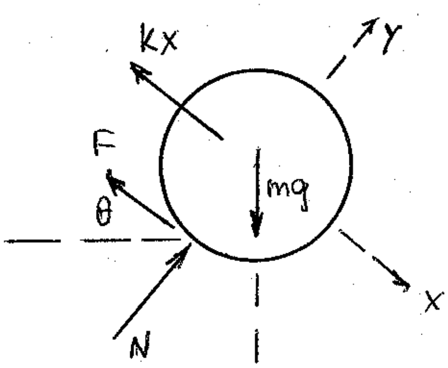


$$\overset{+\searrow}{\sum F_x} = -F - Kx + mg\sin\theta = ma$$

$$= -F - 3X + 12\sin 30^\circ = \frac{12}{32.17}a$$

$$\overset{+\nearrow}{\sum F_y} = N - mg\cos\theta = 0$$

$$N = 12\cos 30^\circ = 10.39 \text{ lb}$$



$$\overset{\curvearrowright +}{\sum M_c} = F\left(\frac{12}{32.17}\right) = I\alpha = \frac{1}{2}mR^2\left(\frac{a}{R}\right)$$

$$F = \frac{1}{2}\left(\frac{12}{32.17}\right)a = .1865\,a$$

$$-.1865a - 3X + 6 = .373a$$

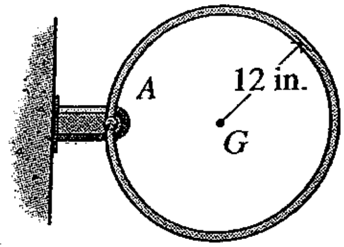
$$-3x + 6 = .559\, v\frac{dv}{dx}$$

$$-3\int_0^2 x\,dx + 6\int_0^2 dx = .559\int_0^V v\,dv$$

$$-\frac{3(2^2)}{2} + 6(2) = .559\,\frac{V^2}{2}$$

$$V = 4.63 \text{ ft/sec}$$

A thin ring, 24 inches in diameter, weighs 5 lbs and rotates in a vertical plane about a point A with an angular velocity of 10 rad/sec counterclockwise. For the position shown, determine a) the angular acceleration α of the ring about A, and b) the x and y components of the force at A.



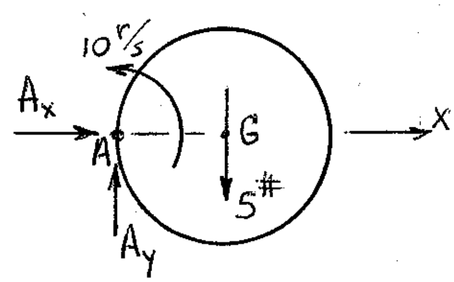
For the ring $I_A = mr^2 + mr^2 = 2mr^2$

$$= \frac{5}{32.17}(2)(1)^2$$

$$= 0.3108 \text{ slug ft}^2$$

$$\xrightarrow{+} \sum F_x = A_x = \frac{5}{32.17} a_{Gx} = \frac{5}{32.17}\left(-\frac{12}{12}\right)10^2$$

$$A_x = 15.54 \text{ lb} \leftarrow$$

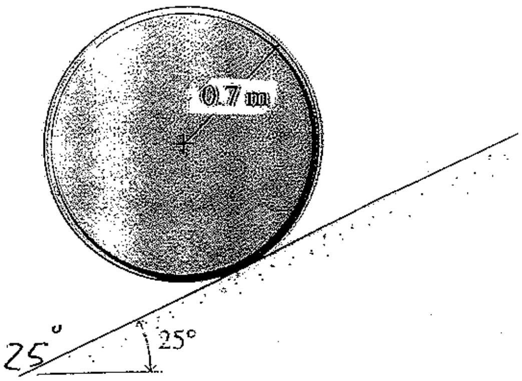


$$+\downarrow \sum F_y = -A_y + 5 = \frac{5}{32.17}\left(\frac{12}{12}\right)\alpha = .155\,\alpha$$

$$\circlearrowleft + \sum M_A = \left(\frac{12}{12}\right)5 = .3108\,\alpha \qquad \alpha = 16.08 \text{ r/s}^2 \circlearrowright$$

$$A_y = 5 - .155(16.08) = 2.50 \text{ lb} \uparrow$$

A 45-kg cylinder is placed on a 25° inclined surface from rest as shown. The diameter of the cylinder is 1.4 m. The cylinder rolls without slipping. Use the energy method to determine a) the angular velocity, ω and b) the angular acceleration, α of the cylinder after it has rolled 10 meters. down the incline.

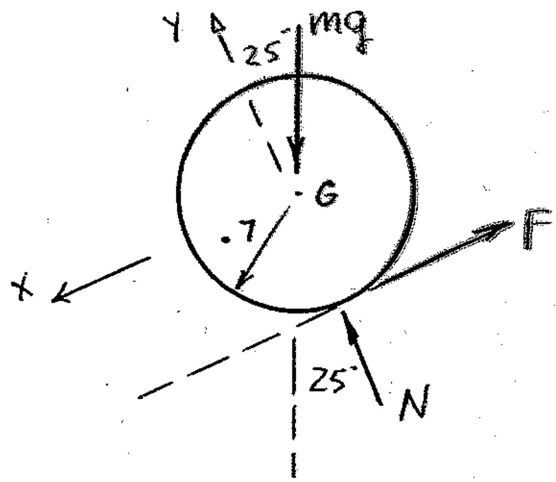


$$T_1 + V_1 + U_{1-2} = T_2 + V_2$$

$$0 + 0 + 0 = \frac{3}{4}(45)v_2^2 - (45)(9.81)(10)\sin 25°$$

$v = 7.43$ m/s

$$\omega = \frac{v}{r} = \frac{7.43}{.7} = \underline{10.62 \text{ rad/sec}}$$



$$\overset{+}{\swarrow} \sum F_x = (45)(9.81)\sin 25° - F$$

$$= (45)a = 45(.7)\alpha$$

or $\quad F = 186.56 - 31.5\alpha$

$$\circlearrowleft + \sum M_G = .7F = I\alpha = \frac{1}{2}(45)(.7)^2\alpha$$

or $\quad F = 15.75\alpha$ $\qquad \underline{\alpha = 3.95 \text{ rad/sec}^2}$

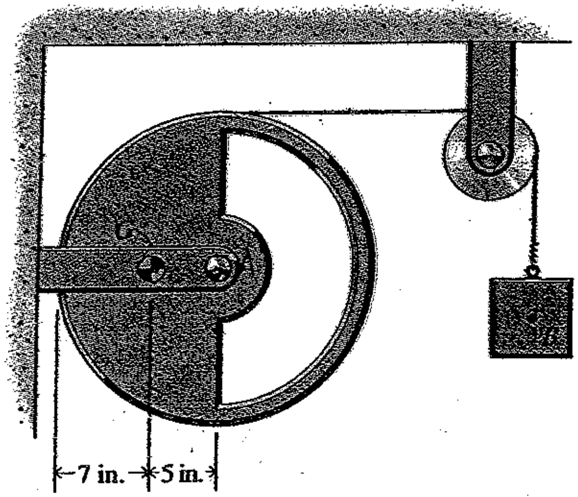
Confirmation:

$$\alpha = \omega \frac{d\omega}{d\theta} \qquad \int_0^\theta \alpha \, d\theta = \int_0^\omega \omega \, d\omega$$

$$2\alpha\theta = \omega^2 \qquad \theta = \frac{10}{.7} = 14.286 \text{ rad}$$

$$\omega^2 = 2(3.95)(14.286) \qquad \omega = 10.62 \text{ rad/sec}$$

A 24-in diameter disk weighs 130 lbs and has a radius of gyration about point A of $k_A = 9$ inches. A cord wrapped around the periphery of the disk passes over a small pulley of negligible mass and is attached to a 70-lb block B. The system is released from rest. Determine a) the tension in the cord, and b) the acceleration of the block as the motion begins.



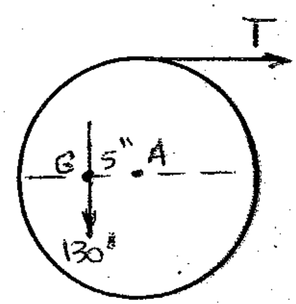
$$\circlearrowleft + \sum M_A = \frac{12}{12} T - \frac{5}{12}(130)$$

$$= I_A \alpha = 2.27 \alpha$$

$$T = 54.17 + 2.273 \alpha$$

$$a_B = \frac{12}{12} \alpha$$

$$+\downarrow \sum F_B = 70 - T = \frac{70}{32.17} a_B$$



$$T = 70 - 2.176 \alpha = 54.17 + 2.273 \alpha$$

$$\alpha = 3.558 \text{ r/s}^2$$

$$a_B = 3.558 \text{ ft/sec}^2$$

$$T = 62.25^{\#}$$