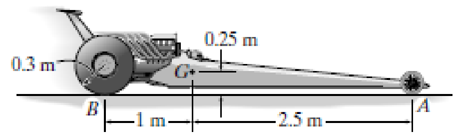
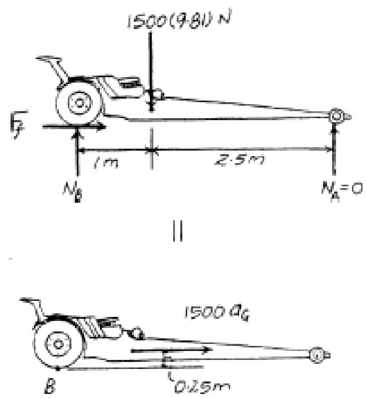
17–31. The dragster has a mass of 1500 kg and a center of mass at G. If the coefficient of kinetic friction between the rear wheels and the pavement is $\mu_k = 0.6$, determine if it is possible for the driver to lift the front wheels, A, off the ground while the rear drive wheels are slipping. Neglect the mass of the wheels and assume that the front wheels are free to roll.



If the front wheels A lift off the ground, then $N_A = 0$.

$\circlearrowleft + \Sigma M_B = \Sigma (M_k)_B;$ $\quad -1500(9.81)(1) = -1500a_G(0.25)$

$$a_G = 39.24 \text{ m/s}^2$$

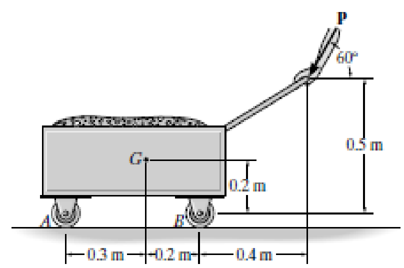


$\xrightarrow{+} \Sigma F_x = m(a_G)_x;$ $\quad F_f = 1500(39.24) = 58860 \text{ N}$

$+\uparrow \Sigma F_y = m(a_G)_y;$ $\quad N_B - 1500(9.81) = 0 \quad N_B = 14715 \text{ N}$

Since the required friction $F_f > (F_f)_{max} = \mu_k N_B = 0.6(14715) = 8829$ N, **it is not possible to lift the front wheels off the ground.** **Ans.**

•**17–45.** The handcart has a mass of 200 kg and center of mass at G. Determine the largest magnitude of force **P** that can be applied to the handle so that the wheels at A or B continue to maintain contact with the ground. Neglect the mass of the wheels.



$\xleftarrow{+} \Sigma F_x = m(a_G)_x;$ $\quad P \cos 60° = 200a_G$

$+\uparrow \Sigma F_y = m(a_G)_y;$ $\quad N_A + N_B - 200(9.81) - P \sin 60° = 0$

$\circlearrowleft + \Sigma M_G = 0;$ $\quad -N_A(0.3) + N_B(0.2) + P \cos 60°(0.3) - P \sin 60°(0.6) = 0$

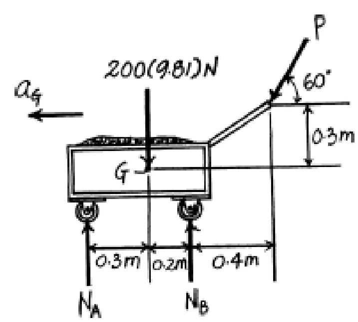
For P_{max}, require

$$N_A = 0$$

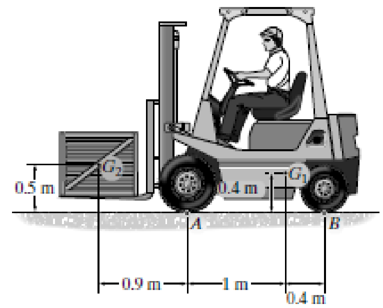
$$P = 1998 \text{ N} = 2.00 \text{ kN}$$ **Ans.**

$$N_B = 3692 \text{ N}$$

$$a_G = 4.99 \text{ m/s}^2$$



17–47. The 1-Mg forklift is used to raise the 750-kg crate with a constant acceleration of $2\,\text{m/s}^2$. Determine the reaction exerted by the ground on the pairs of wheels at A and at B. The centers of mass for the forklift and the crate are located at G_1 and G_2, respectively.



Equations of Motion: $\mathbf{N}_B$ can be obtained directly by writing the moment equation of motion about point A.

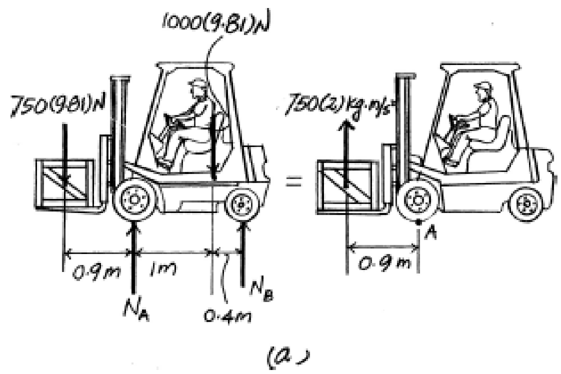
$$\zeta + \Sigma M_A = (M_k)_A; \quad N_B(1.4) + 750(9.81)(0.9) - 1000(9.81)(1) = -750(2)(0.9)$$

$$N_B = 1313.03 \text{ N} = 1.31 \text{ kN}$$ **Ans.**

Using this result to write the force equation of motion along the y axis,

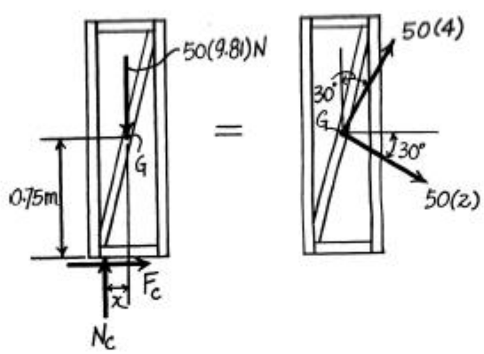
$$+\uparrow \Sigma F_y = m(a_G)_y; \quad N_A + 1313.03 - 750(9.81) - 1000(9.81) = 750(2)$$

$$N_A = 17354.46 \text{ N} = 17.4 \text{ kN}$$ **Ans.**

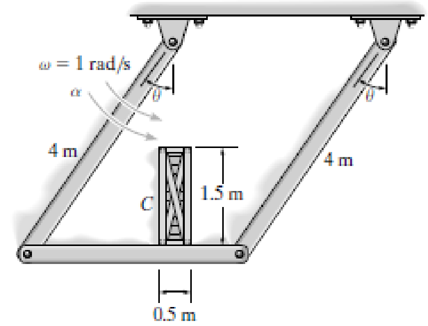


(a)

Thus, $F_C = 187$ N **Ans.**



•**17–53.** The 50-kg uniform crate rests on the platform for which the coefficient of static friction is $\mu_s = 0.5$. If at the instant $\theta = 30°$ the supporting links have an angular velocity $\omega = 1$ rad/s and angular acceleration $\alpha = 0.5$ rad/s², determine the frictional force on the crate.



Curvilinear Translation:

$(a_G)_n = (1)^2(4) = 4\ \text{m/s}^2$

$(a_G)_t = 0.5(4)\ \text{m/s}^2 = 2\ \text{m/s}^2$

$\xrightarrow{+} \Sigma F_x = m(a_G)_x;\qquad F_C = 50(4)\sin 30° + 50(2)\cos 30°$

$+\uparrow \Sigma F_y = m(a_G)_y;\qquad N_C - 50(9.81) = 50(4)\cos 30° - 50(2)\sin 30°$

Solving,

$F_C = 186.6$ N

$N_C = 613.7$ N

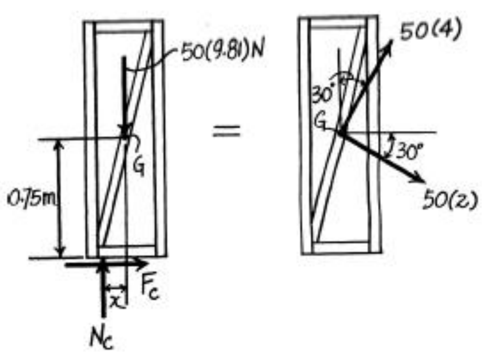
$(F_C)_{max} = 0.5(613.7) = 306.9\ \text{N} > 186.6\ \text{N}$ **OK**

$\circlearrowleft + \Sigma M_G = \Sigma(M_k)_G;\qquad N_C(x) - F_C(0.75) = 0$

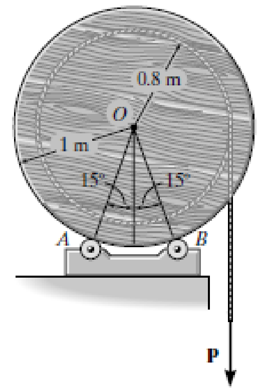
$613.7(x) - 186.6(0.75) = 0$

$x = 0.228\ \text{m} < 0.25\ \text{m}$ **OK**

Thus, $F_C = 187$ N **Ans.**



17–59. The uniform spool is supported on small rollers at A and B. Determine the constant force **P** that must be applied to the cable in order to unwind 8 m of cable in 4 s starting from rest. Also calculate the normal forces on the spool at A and B during this time. The spool has a mass of 60 kg and a radius of gyration about O of $k_O = 0.65$ m. For the calculation neglect the mass of the cable and the mass of the rollers at A and B.



$$(\downarrow +)\ s = s_0 + v_0 t + \frac{1}{2} a_c t^2$$

$$8 = 0 + 0 + \frac{1}{2} a_c (4)^2$$

$$a_c = 1 \text{ m/s}^2$$

$$\alpha = \frac{1}{0.8} = 1.25 \text{ rad/s}^2$$

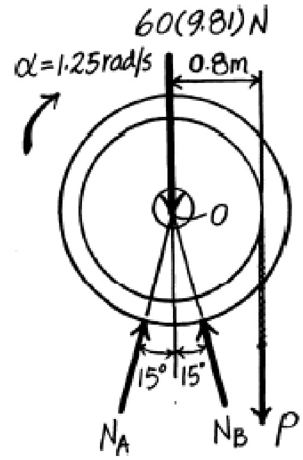
$$\circlearrowleft + \Sigma M_O = I_O \alpha; \qquad P(0.8) = 60(0.65)^2(1.25)$$

$$P = 39.6 \text{ N} \qquad \textbf{Ans.}$$

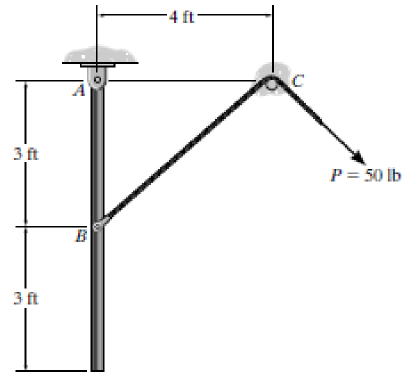
$$\xrightarrow{+} \Sigma F_x = m a_x; \qquad N_A \sin 15° - N_B \sin 15° = 0$$

$$+\uparrow \Sigma F_y = m a_y; \qquad N_A \cos 15° + N_B \cos 15° - 39.6 - 588.6 = 0$$

$$N_A = N_B = 325 \text{ N} \qquad \textbf{Ans.}$$



17–70. The 100-lb uniform rod is at rest in a vertical position when the cord attached to it at B is subjected to a force of $P = 50$ lb. Determine the rod's initial angular acceleration and the magnitude of the reactive force that pin A exerts on the rod. Neglect the size of the smooth peg at C.



Equations of Motion: Since the rod rotates about a fixed axis passing through point A, $(a_G)_t = \alpha r_G = \alpha(3)$ and $(a_G)_n = \omega^2 r_G = 0$. The mass moment of inertia of the rod about G is $I_G = \frac{1}{12}\left(\frac{100}{32.2}\right)(6^2) = 9.317$ slug · ft². Writing the moment equation of motion about point A,

$$\circlearrowleft + \Sigma M_A = (M_k)_A; \qquad 50\left(\frac{4}{5}\right)(3) = \frac{100}{32.2}[\alpha(3)](3) + 9.317\alpha$$

$$\alpha = 3.220 \text{ rad/s}^2 = 3.22 \text{ rad/s}^2$$ **Ans.**

This result can also be obtained by applying $\Sigma M_A = I_A\alpha$, where

$$I_A = 9.317 + \left(\frac{100}{32.2}\right)(3^2) = 37.267 \text{ slug} \cdot \text{ft}^2$$

Thus,

$$\circlearrowleft + \Sigma M_A = I_A\,\alpha; \qquad 50\left(\frac{4}{5}\right)(3) = 37.267\alpha$$

$$\alpha = 3.220 \text{ rad/s}^2 = 3.22 \text{ rad/s}^2$$ **Ans.**

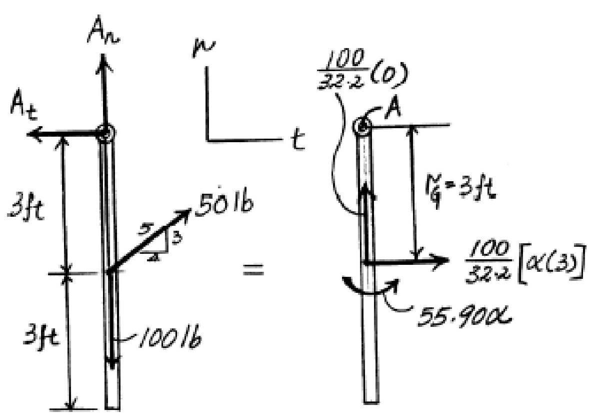
Using this result to write the force equation of motion along the n and t axes,

$$+\uparrow \Sigma F_n = m(a_G)_n; \qquad A_n + 50\left(\frac{3}{5}\right) - 100 = \frac{100}{32.2}(0) \qquad A_n = 70 \text{ lb}$$

$$\overset{+}{\rightarrow} \Sigma F_t = m(a_G)_t; \qquad 50\left(\frac{4}{5}\right) - A_t = \frac{100}{32.2}[3.220(3)] \qquad A_t = 10.0 \text{ lb}$$

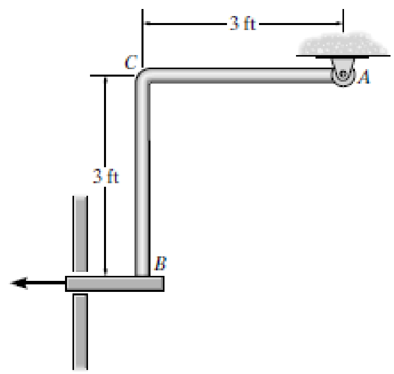
Thus,

$$F_A = \sqrt{A_t^2 + A_n^2} = \sqrt{10^2 + 70^2} = 70.7 \text{ lb}$$ **Ans.**

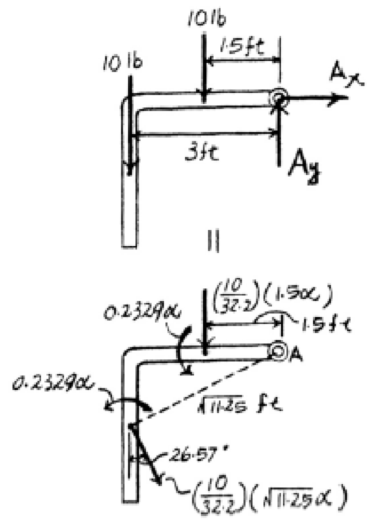


(a)

17–79. If the support at B is suddenly removed, determine the initial horizontal and vertical components of reaction that the pin A exerts on the rod ACB. Segments AC and CB each have a weight of 10 lb.



Equations of Motion: The mass moment inertia of the rod segment AC and BC about their respective mass center is $I_G = \frac{1}{12}ml^2 = \frac{1}{12}\left(\frac{10}{32.2}\right)(3^2) = 0.2329\ \text{slug}\cdot\text{ft}^2$. At the instant shown, the normal component of acceleration of the mass center for rod segment AB and BC are $[(a_G)_n]_{AB} = [(a_G)_n]_{BC} = 0$ since the angular velocity of the assembly $\omega = 0$ at that instant. The tangential component of acceleration of the mass center for rod segment AC and BC are $[(a_G)_t]_{AB} = 1.5\,\alpha$ and $[(a_G)_t]_{BC} = \sqrt{11.25}\alpha$.



$$\circlearrowleft +\Sigma M_A = \Sigma(M_k)_A; \quad 10(1.5) + 10(3) = 0.2329\alpha + \left(\frac{10}{32.2}\right)(1.5\alpha)(1.5) + 0.2329\,\alpha + \left(\frac{10}{32.2}\right)(\sqrt{11.25}\alpha)(\sqrt{11.25})$$

$$\alpha = 9.660\ \text{rad/s}^2$$

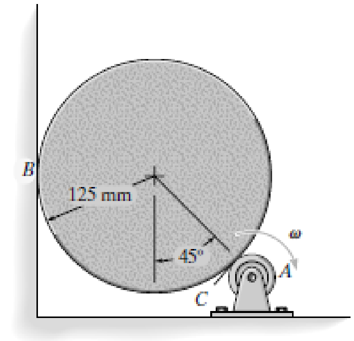
$$\xrightarrow{+} \Sigma F_x = m(a_G)_x; \quad A_x = \left(\frac{10}{32.2}\right)[\sqrt{11.25}(9.660)]\sin 26.57^\circ$$

$$A_x = 4.50\ \text{lb} \qquad \textbf{Ans.}$$

$$+\uparrow \Sigma F_y = m(a_G)_y; \quad A_y - 20 = -\left(\frac{10}{32.2}\right)[1.5(9.660)] - \left(\frac{10}{32.2}\right)[\sqrt{11.25}(9.660)]\cos 26.57^\circ$$

$$A_y = 6.50\ \text{lb} \qquad \textbf{Ans.}$$

17–86. The 5-kg cylinder is initially at rest when it is placed in contact with the wall B and the rotor at A. If the rotor always maintains a constant clockwise angular velocity $\omega = 6$ rad/s, determine the initial angular acceleration of the cylinder. The coefficient of kinetic friction at the contacting surfaces B and C is $\mu_k = 0.2$.

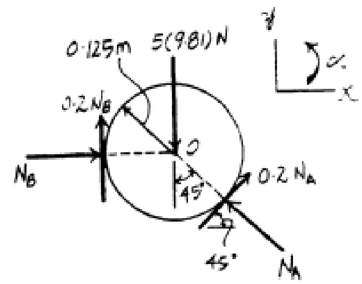


Equations of Motion: The mass moment of inertia of the cylinder about point O is given by $I_O = \frac{1}{2}mr^2 = \frac{1}{2}(5)(0.125^2) = 0.0390625\ \text{kg}\cdot\text{m}^2$. Applying Eq. 17–16, we have

$$\xrightarrow{+} \Sigma F_x = m(a_G)_x; \qquad N_B + 0.2N_A \cos 45° - N_A \sin 45° = 0 \qquad \textbf{(1)}$$

$$+\uparrow \Sigma F_y = m(a_G)_y; \qquad 0.2N_B + 0.2N_A \sin 45° + N_A \cos 45° - 5(9.81) = 0 \qquad \textbf{(2)}$$

$$\circlearrowleft + \Sigma M_O = I_O\alpha; \qquad 0.2N_A(0.125) - 0.2N_B(0.125) = 0.0390625\alpha \qquad \textbf{(3)}$$



Solving Eqs. (1), (2), and (3) yields;

$$N_A = 51.01\ \text{N} \qquad N_B = 28.85\ \text{N}$$

$$\alpha = 14.2\ \text{rad/s}^2 \qquad \textbf{Ans.}$$