17-71. If the support at B is suddenly removed, determine the initial downward acceleration of point C. Segments AC and CB each has a weight of 10 N (= 1 kg).

\[ I = \frac{1}{3} \left( \frac{10}{9.81} \right) (3)^2 + \frac{1}{2} \left( \frac{10}{9.81} \right) (3)^2 + \frac{10}{9.81} (1.5)^2 + 3^3 \]

\[ = 15.291 \text{ kg} \cdot \text{m}^2 \]

\[ \sum M_A = I \alpha; \quad 10(3) + 10(1.5) = 15.291 \alpha \]

\[ \alpha = \frac{15.291 \times 3}{10} = 4.58 \text{ m/s}^2 \]

Ans

*17-72. Determine the angular acceleration of the 25-kg diving board and the horizontal and vertical components of reaction at the pin A the instant the man jumps off. Assume that the board is uniform and rigid, and that at the instant he jumps off the spring is compressed a maximum amount of 200 mm, \( \phi = 0 \), and the board is horizontal. Take \( k = 7 \text{ kN/m} \).

\[ \sum M_A = I \alpha; \quad 1.5(1400 - 245.25) = \left( \frac{25(0.3)^2}{2} \right) \alpha \]

\[ \alpha = \frac{1400 - 245.25 - A_v}{25(1.50)} \]

\[ A_x = \text{Ans} \]

\[ A_y = 245.25 \text{ N} \]

\[ = 0 \]

\[ \text{Ans} \]

\[ A_y = 289 \text{ N} \]

\[ \alpha = 23.1 \text{ m/s}^2 \]

\[ \text{Ans} \]
17-73. The disk has a mass of 20 kg and is originally spinning at the end of the strut with an angular velocity of \( \omega = 60 \text{ rad/s} \). If it is then placed against the wall, for which the coefficient of kinetic friction is \( \mu_k = 0.3 \), determine the time required for the motion to stop. What is the force in strut BC during this time?

\[
\begin{align*}
\sum \mathbf{F}_r &= m\omega(\omega) \\
F_x \sin 30^\circ - N_x &= 0 \\
n^2 \mathbf{F}_x &= m\omega(\omega) \\
F_x \cos 30^\circ - 209.83 &= 0.25N_x = 0 \\
2M \omega = I\alpha \\
0.3\nu(0.15) &= \left[ \frac{1}{2} \left( \frac{20(0.15)^2}{2} \right) \right] \alpha \\
N_x &= 96.6 \text{ N} \\
F_x &= 193 \text{ N} \quad \text{Ans} \\
\alpha &= 19.3 \text{ rad/s}^2 \quad \text{Ans} \\
\omega &= \omega_0 + \alpha t \\
0 &= 60 + (-19.3)t \\
t &= 3.11 \text{ s} \quad \text{Ans}
\end{align*}
\]

17-74. The disk has a mass \( M \) and a radius \( R \). If a block of mass \( m \) is attached to the cord, determine the angular acceleration of the disk when the block is released from rest. Also, what is the velocity of the block after it falls a distance \( 2R \) starting from rest?

\[
\begin{align*}
\sum \mathbf{F}_r &= 2I\omega\omega \\
m\bar{g}R &= \frac{1}{2}m(2R)^2 + m\omega^2R \\
\alpha &= \frac{2mgR}{2mR(M + 2m)} \quad \text{Ans} \\
\omega &= \omega_0 + \alpha t \\
v^2 &= v_0^2 + 2\alpha \left( v - v_0 \right) \\
v^2 &= 0 + 2 \left( \frac{2mgR}{R(M + 2m)} \right) \left( 2R - 0 \right) \\
v &= \frac{2mgR}{(M + 2m)} \quad \text{Ans}
\end{align*}
\]

17-75. The two blocks \( A \) and \( B \) have a mass \( m_a \) and \( m_b \), respectively, where \( m_a > m_b \). If the pulley can be treated as a disk of mass \( M \), determine the acceleration of block \( A \). Neglect the mass of the cord and any slipping on the pulley.

\[
\begin{align*}
\sum \mathbf{F}_r &= 2I\omega\omega \\
m_a\bar{g}R = m_a\omega^2R = \left( \frac{1}{2}M \right) \alpha + m_a\omega^2R = m_a\omega^2R \\
\alpha &= \frac{\left[ m_a\omega_0^2R - m_b \right]}{\left( \frac{1}{2}M + m_a + m_b \right)} \\
\alpha &= \frac{\left[ m_a\omega_0^2R - m_b \right]}{\left( \frac{1}{2}M + m_a + m_b \right)} \quad \text{Ans}
\end{align*}
\]

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17.105. The uniform bar of mass \( m \) and length \( L \) is balanced in the vertical position when the horizontal force \( P \) is applied to the roller at \( A \). Determine the bar’s initial angular acceleration and the acceleration of its top point \( B \).

\[ P = \frac{ma_\theta}{L} \]

\[ P\left(\frac{L}{2}\right) = \left(\frac{1}{12}ml^2\right)a \]

\[ a = \frac{6P}{ml} \]

\[ a_\theta = \frac{P}{m} \frac{L}{2} \]

\[ a_B = \frac{2P}{mL} \]

\[ a_\theta = \frac{P}{m} \frac{L}{2} \frac{1}{\left(\frac{6P}{ml}\right)} \]

\[ a_B = \frac{2P}{mL} \]
**17.106.** The ladder has a weight $W$ and rests against the smooth wall and ground. Determine its angular acceleration as a function of $\theta$ when it is released and allowed to slide downward. For the calculation, treat the ladder as a slender rod.

**Equation of Motion:** The mass moment of inertia of the ladder about its mass center is given by
$$I_c = \frac{1}{12}mL^2 = \frac{1}{12} \left( \frac{W}{g} \right) L^2.$$ Applying Eq. 17.16, we have

$$\dot{X} = X_0 \ddot{a_0}, \quad N_B(- \dot{L} \sin \theta) - W \left( \frac{1}{2} \dot{L} \cos \theta \right) = - \left( \frac{W}{g} \right) \dot{L} \cos \theta,$$

$$+ \left( \frac{W}{g} \right) \dot{a_0} \left( \frac{1}{2} \dot{L} \cos \theta \right)$$

$$- \left( \frac{W}{g} \right) \frac{1}{2} \dot{L} \sin \theta$$

$$\Delta \times \dot{a_0} = m \ddot{a_0}$$

$$N_B = \left( \frac{W}{g} \right) \dot{a_0}.$$ \[1\]

**Kinematic:** At the instant the ladder being released, the angular velocity of the ladder, $\omega = 0$. Analyzing the motion of points $A$ and $B$ by applying Eq. 16-18 with $v_{A0} = (\cos \theta \dot{L} - \dot{Y} \sin \theta)$, we have

$$\dot{a_0} = \dot{a_0} + \dot{\alpha} \times r_{A0} - \omega \times r_{A0}$$

$$-\dot{\alpha} = -\omega \times \dot{a_0} + (\cdot \omega \times r_{A0}) \times (\cos \theta \dot{L} - \dot{Y} \sin \theta)$$

$$-\dot{\alpha} = (-\dot{L} \sin \theta) \dot{a_0} + ((\dot{L} \cos \theta) \dot{a_0} - \dot{a_0})$$

Equating $\dot{a}_0$ component, we have

$$0 = (\dot{L} \cos \theta) \dot{a_0} - \dot{a_0}$$

$$a_0 = (\dot{L} \cos \theta) \dot{a_0}$$

Analyzing the motion of points $A$ and $G$ by applying Eq. 16-18 with $v_{A0} = (\frac{1}{2} \cos \theta \dot{L} - \dot{Y} \sin \theta)$, we have

$$\dot{a_0} = \dot{a_0} + \dot{\alpha} \times r_{A0} - \omega \times r_{A0}$$

$$\dot{a_0} + \dot{\alpha} \times (\dot{a_0}) = (\dot{L} \cos \theta) \dot{a_0} + (\cdot \omega \times r_{A0}) \times (\frac{1}{2} \cos \theta \dot{L} - \dot{Y} \sin \theta)$$

Substituting the results obtained above into Eqs. [1] and [2] and solving yields

$$N_B = \frac{3W}{g} \sin \theta$$

$$\alpha = \frac{3W}{g} \cos \theta$$

Ans.
17-113. The 5-kN (=500-kg) beam is supported at A and B when it is subjected to a force of 10 kN as shown. If the pin support at A suddenly fails, determine the beam’s initial angular acceleration and the force of the roller support on the beam. For the calculation, assume that the beam is a slender rod so that its thickness can be neglected.

\[ \sum \mathbf{F}_x = m(\alpha \mathbf{i}) \]
\[ = 10 \times 0.5 - \frac{5000}{9.81} = 5000 \times 9.81 \]

\[ \sum \mathbf{M}_A = \sum (\mathbf{M}_{Ac}) \]
\[ = 5000(3) + 10 \times 0.5 - \frac{5000}{9.81} = 5000 \times 9.81 \]

\[ \alpha = \frac{15000}{9.81 \times 10^3} \]

\[ \alpha = 7.13 \text{ rad/s}^2 \quad \text{Ans} \]

\( R_B = 97.86 \text{ N} \quad \text{Ans} \)

(+) if \( \theta_A \), \( \theta_B \) is negative.

\[ \theta_A < 0 \] means that the beam stays in contact with roller support.