(1) 5.12
(a) \[ F = m_1a_1 = m_2a_2 \implies \frac{m_1}{m_2} = \frac{a_2}{a_1} = \frac{3.00}{1.00} = 3.00 \]

(b) \[ F = (m_1+m_2)a = a = \frac{F}{m_1+m_2} = \frac{m_2a_2}{m_1+m_2} = \frac{a_2}{\left(\frac{m_1}{m_2} + 1\right)} = \frac{100 \text{ m/s}^2}{4.00} \]
\[ a = 0.25 \text{ m/s}^2 \]

(2) 5.20
(a) \[ T = 5.00 \text{ kg} \times (9.8 \text{ m/s}^2) = 49 \text{ N} \]

(b) \[ T = 5.00 \text{ kg} \times (9.8 \text{ m/s}^2) = 49 \text{ N} \]

(c) \[ W = 10.00 \text{ kg} \times (9.8 \text{ m/s}^2) = 98 \text{ N} \]

(d) \[ T = 5.00 \text{ kg} \times (9.8 \text{ m/s}^2) \sin 30^\circ = 24.5 \text{ N} \]

(3) 5.26

(a) \[ T = (8.00 \text{ kg}) \times (9.8 \text{ m/s}^2) = 78.4 \text{ N} \text{ holds up weight} \]

(b) \[ F \begin{array}{c} \text{on leg is horizontal component of both pulley tensions (reaction force)} \end{array} \]
\[ F = T + T \cos 70^\circ = 78.4 \text{ N} \times \left(1 + \cos 70^\circ\right) = 105 \text{ N} \]

(4) 5.39

\[ f_s = 75.0 \text{ N} = \mu_smg \quad \text{or} \quad \mu_s = \frac{f_s}{mg} = \frac{75.0 \text{ N}}{25.0 \text{ kg} \times 9.8 \text{ m/s}^2} = 0.31 \]

\[ f_k = 60.0 \text{ N} = \mu_kmg \quad \text{or} \quad \mu_k = \frac{f_k}{mg} = \frac{60.0 \text{ N}}{28 \text{ kg} \times 9.8 \text{ m/s}^2} = 0.24 \]

\[ \text{force balance if } a = 0 \]
(5) \(5.42 \text{ (a) } t = 4.43 \text{ s } \quad d = \frac{1}{4} \text{ mi} = \frac{1}{2} \text{ at}^2 \Rightarrow a = \frac{2d}{t^2} \)

Assume static friction, drives car forward.

\[ f_s = \mu_s m g = m a = m \frac{2d}{t^2} \Rightarrow \mu_s = \frac{2d}{gt^2} \]

\[ \mu_s = \frac{2 \times (5280 \text{ ft} + 14)}{32 \times (4.43 \text{ s})^2} = 4.2 \text{ ! very sticky!} \]

(b) time would increase with more engine power, because wheels would slip and \( \mu_k < \mu_s \).

(6) \(5.57 \)

scale measures \( T \) in left rope

\[ T = 250 \text{ N} \]

\( 250 \text{ N} = T \)

which equals \( T \) in right rope since pulley is frictionless and massless.

\( T \)

Nick and chair as one system:

Nick and chair as separate systems:

Nick: \( (m_n + m_c) a = 2T - (m_n + m_c) g \)

\( = 2T - W_n - W_c \)

\[ \Rightarrow \]

\[ W_n + W_c \]

\[ 320 \text{ N} \quad 160 \text{ N} \]

\[ (m_n + m_c) a = 20 \text{ N} \quad \text{up} \]

\[ \Rightarrow \]

\[ \frac{W_n + W_c}{g} = 20 \text{ N} \quad \text{up} \]

\[ \Rightarrow \]

\[ a = \frac{9}{480} \frac{\text{N}}{\text{m}^2} \]

(b) \( a = 0.41 \text{ m/s}^2 \)

(c) \( (m_n - m_c) a = 2F_n - W_n + W_c = 2F_n = (W_n - W_c) a + W_n - W_c \)

\[ \Rightarrow \]

\[ F_n = \frac{a}{2} + W_n - W_c \]

\[ \Rightarrow \]

\[ F_n = 83 \text{ N} \]
(a) Al-steel $\mu_s = 0.61$, $\mu_k = 0.47$
Cu-steel $\mu_s = 0.53$, $\mu_k = 0.36$

Lack at both masses, $T$ is internal force => ignore

$\mu_s m_2 g \sin \theta > f_1 + f_2$ if so => $a > 0$

$\mu_k m_2 g \sin \theta = \mu_s m_1 g + \mu_s m_2 g \cos \theta$

$(f_1 + f_2)_{\text{max}} = \text{frictional force}$

\[ 29.4 \text{ N} = 12.0 \text{ N} + 27.0 \text{ N} = 39.0 \text{ N} \]

=> stick.

(d) $f_1 + f_2 = m_2 g \sin \theta = 29.4 \text{ N}$

If they do slide => $(m_1 + m_2) a = m_2 g \sin \theta - f_1 - f_2$

gives $a$ then use $m_1$ (say) to get $T$

$m_1 a = T - f_1 = T = m_1 a + f_1$

(a) $5.67$

All frictionless => $T = m_2 g$

if stationary w.r.t. $M$

\[ m_2 a = m_1 g \]

\[ F = (M + m_1) a \]

\[ m_2 a = m_1 g \]

\[ F = (m_1 + m_2) \frac{m_1 g}{m_2} \]

\[ a = \frac{m_1 g}{m_2} \]
\[ a = \frac{30.0 \text{ m/s}^2}{6.0 \text{ s}} = 5.0 \text{ m/s}^2 \]

\( T = mg \cos \theta \)

\( T = 0.84 \text{ N} \)

\( T = mg \cos \theta \tan \theta \)

\( ma = mg \sin \theta \)

\( \sin \theta = \frac{a}{g} = 0.51 \)

\( \theta = 30.7^\circ \)

Can also rotate by \( \theta \):

\[ T = mg \cos \theta \]

\( ma = mg \sin \theta \)

\[ \mu_s F = mg \sin \theta \]

\[ f_s = \mu_s F \]

\[ 2f_s = W \text{ (static)} \]

\[ \mu_s F > \frac{W}{2} \]

\[ F > \frac{W}{2\mu_s} = 72.0 \text{ N} \text{ on each side} \]

\[ (144 \text{ N total}) \]