\[ T = m_\text{ax} \cdot a_\text{ax}, \quad N_1 - m_\text{ag} = m_\text{ag} \]
\( T \cos \theta = m_b a_{bx} \quad T \sin \theta - m_b g = a_{by}/m_0 \)

\[ F - T \cos \theta - \dot{T} = m_a a_{cx} \quad -T \sin \theta - N_1 + N_2 = m_a a_{cy} \]

Now

\( a_{bx} = a_{cx} = a_{ax} = a \quad \text{and} \quad a_{ay} = a_{by} = a_{cy} = 0 \)

\( \text{all } x \text{- accel the same} \quad \text{not moving up} \quad \text{and down} \)

So the \( x \) equations become and one \( y \)-equation:

\( T = m_a a \quad T \sin \theta - m_b g = 0 \)

\( T \cos \theta = m_b a \)

\( F = T + T \cos \theta + m_a a \)

Unknowns: \( T, a, \theta, F \)  \( \text{Eqs} = 4 \)

Now working, we first eliminate \( T \)

1. \( m_a \dot{a} \cos \theta = m_b a \)
2. \( m_a \dot{a} \sin \theta = m_b g \)
   or \( \cos \theta = m_b / m_a \)

3. \( F = m_a a + m_a a \cos \theta + m_c a \)
\[ F = a \left( m_a + m_a \cos \theta + m_c \right) \]
\[ = a \left( m_a + m_a \frac{m_b}{m_a} + m_c \right) \]
\[ F = a \left( m_a + m_b + m_c \right) \text{ -- obvious!} \]

Now using \[ \sin \theta = \sqrt{1 - \cos^2 \theta} = \sqrt{1 - \frac{m_b^2}{m_a^2}} \]

We use (2) to get \[ a = \frac{m_B g}{m_a \sin \theta} = \frac{m_B}{m_a \sqrt{1 - \frac{m_b^2}{m_a^2}}} \]

So \[ F = \frac{m_B}{\sqrt{m_a^2 - m_b^2}} \left( m_a + m_b + m_c \right) \]
4.54

So Newton's Law

\[ T_c - 2T = m_p g \]
\[ T - m_a g = m_a a \]
\[ T - m_b g = m_b a \]

Now with \( a_a + a_b = 0 \) \( a_a = -a_b = a \) we get

\[ T - m_a g = m_a a \]
\[ T - m_b g = m_b (-a) \]

\[ \frac{1}{m_a} - g = a \Rightarrow T - m_b g = -m_b \left( \frac{I - g}{m_a} \right) \]

\[ T \left( \frac{1 + m_b}{m_a} \right) = 2m_b g \]

\[ T = \frac{2m_b g}{1 + m_b/m_a} \]

So

\[ T_c = 2T = 4m_b g = \frac{4m_b m_a g}{m_a + m_b} \quad m_a = 1.2 \]
\[ m_b = 3.2 \]
\[ g = 9.8 \]

\[ T = 34.2 \text{ N} \]
Solution draw a fictitious box around relevant parts

\[
T = \left(m_A + m_c \frac{l_A}{l_A + l_B}\right) a_A
\]
\[
T = \left(m_B + m_c \frac{l_B}{l_B + l_A}\right) g
\]

This is the mass of the "B" core.

So, mass of a + cord mass

\[
T = \left(m_B + m_c \frac{l_B}{l_B + l_A}\right) a_I
\]
Notation \( L = l_A + l_B \) \( x = \frac{l_B}{l_B + l_A} \) fraction of part a

Also \( a_a = -a_b = a \)  
\( l - x = \frac{l_B}{l_B + l_A} \) fraction of part b

So:
\[ T = (m_a + m_c x) a \] and  \[ T - (m_B + m_c l_B) g = [m_B + m_c (1-x)] x (-a) \]

So
\[-(m_a + m_c x) a + (m_B + m_c (1-x)) g = [m_B + m_c (1-x)] (a)\]

\[ m_B + m_c (1-x) g = [m_B + m_c (1-x) + m_a + m_c x] a \]

So
\[ m_B + m_c (1-x) g = a \]

\[ m_a + m_B + m_c \]

\[ \frac{(m_B + m_c l_B)}{l_B + l_A} g = a \]

\[ m_a + m_B + m_c \]

This is the weight of B part \( \frac{\text{Total mass}}{a} \)
Problem 4.56 - see web page

\[ L = 10 \text{m} \quad L = 10 \text{m} \]

Draw a FBD

\[ 2T \sin \theta = mg \]

\[ \theta = \sin^{-1} \left( \frac{mg}{2T} \right) \]

\[ \theta = \sin^{-1} \left( \frac{21 \text{kg} \times 9.8 \frac{\text{m}}{\text{s}^2}}{2 \times 2600 \text{N}} \right) \]

So:

\[ \theta = 0.12 \text{ rad} \]

\[ \tan \theta = \frac{x}{L} \]

\[ x = L \tan \theta = 10 \text{m} \times \tan (0.12) \approx 1.2 \]

For part b we note that for \( \theta \ll 1 \)

\[ \theta = \sin \theta \approx \tan \theta = \frac{x}{L} \]

\[ \text{so} \quad \sin \theta = \frac{mg}{2T} \approx \frac{x}{L} \]

So \[ x = \frac{L \cdot mg}{2T} \] so if \( x \) is \( \rightarrow \) over
So if $x$ is four times smaller, the tension is approximately four times larger.

\[ F_{\text{BD}} - T + F_p - mg = ma \]

\[ \text{FBD of rope end:} \]

\[ T = F_p - mg = ma \]

\[ \text{So } F_p = T \]

Here \[ T + F_p - mg = ma \] \( \Rightarrow \) no accel

\[ 2T = mg \]

\[ F_0^\circ = T = mg/2 \]

Then, if the force is increased by 1.18

\[ T + 1.18F_0^\circ - mg = ma \]

\[ T = 1.18F_0^\circ \]

\[ 2 \cdot 1.18F_0^\circ - mg = ma \]

\[ \not 1.18 \cdot mg - mg = ma \]

\[ 0.18g = a \]
First we determine the accel.

See Lecture 6+7

\[ a_B = g \left( \frac{m_a - m_B}{m_a + m_B} \right) \]

\[ v = 1.8 \, \text{m} \quad a_B = (9.8 \, \text{m/s}^2) \left( \frac{2.2 \, \text{kg} - 3.6 \, \text{kg}}{2.2 \, \text{kg} + 3.6 \, \text{kg}} \right) \]

\[ a_B = -2.3655 \, \text{m/s}^2 \]

The speed of Block \( a \) when \( B \) hits ground is \( v_1 \),

\[ v_1^2 = v_0^2 + 2a_0 \Delta x \]

\[ \Delta x = b = 1.8 \, \text{m} \]

\[ a_0 = -a_B = -2.36 \, \text{m/s}^2 \]

\[ v_1 = \sqrt{2a_0 b} = 2.92 \, \text{m/s} \]

After this time \( a \) continues to rise a dist \( \Delta x \),

\[ v_f^2 = v_1^2 + 2a \Delta x \]

\[ 0 = v_1^2 + -2g \Delta x \]

\[ \frac{v_1^2}{2g} = \Delta x = \frac{(2.92 \, \text{m/s})^2}{2 \times 9.8 \, \text{m/s}^2} = 0.435 \, \text{m} \]

So \( \Delta x \) Total height = \( 2b + \Delta x = 4.035 \, \text{m} \).
Picture

8 hits ground

\[ y_1 \]

\[ 2r \]

\[ \Delta x \]

\[ 2h \]
Draw FBD

So in y direction:

\[ N - m_a g = m_a \frac{a}{y} \]
\[ N_2 - N_1 - m_a g = m_a \frac{a}{y} \]
\[ N_1 = m_a g \]
\[ N_2 = (m_a + m_b) g \]

There is no x accel we have not broken free from static fric yet.

\[ F = T = \mu_s m_a g \]
\[ F = T + \mu_s m_a g + \mu_s (m_a + m_b) g \]
\[ F = \mu_s m_a g + \mu_s m_b g + \mu_s (m_a + m_b) g \]
\[ F = 3\mu_s m_B g + \mu_k m_A g \]

\[ F = 82 N \]

For part B, we know the force \( F_\ast = 1.1 F = 90.2 N \)

y-direction is the same \( a_x = -a_y = a \)

\[-T + \mu_k m_B g = -m_B a \quad -T - \mu_k m_B g - \mu_k (m_a + m_B) g + F_\ast \]

\[ m_B a + \mu_k m_B g = T = m_o a \]

Find \( a \)

\[-m_B a + \mu_k m_B g - \mu_s m_B g - \mu_k (m_a + m_B) g + F_\ast = m_a a \]

So

\[ a = \frac{1}{(m_a + m_B)} \left[ F_\ast - (3\mu_k m_B g + \mu_k m_A g) \right] \]

or

\[ a = \frac{3m_B g + m_A g}{m_a + m_B} \left[ 1.1 \mu_s - \mu_k \right] \quad \text{since} \quad F_\ast = 1.1 \mu_s (3m_B g + m_A g) \]
Snowboard

\[ x = ? \]
\[ x_1 = 110 \text{ m} \]
\[ \mu_k = 0.18 \]
\[ \mu_k = 0.15 \]
\[ v_0 = 5.0 \text{ m/s} \]
\[ \theta = 28^\circ \]

\[ m g \cos \theta - \mu_k N = ma \]
\[ N - mg \cos \theta = ma \]

\[ m g \sin \theta - \mu_k mg \cos \theta = ma \]

\[ g (\sin \theta - \mu_k \cos \theta) = a \] slope

For the flat part we set \( \theta \to 0 \)

\[ \mu_k g = a \] flat

\[ v_f^2 = v_0^2 + 2a \Delta x \] slope

\[ u^2 = v_0^2 + 2g (\sin \theta - \mu_k \cos \theta) \Delta x \] velocity just before flat
For the second part

\[ \sqrt{x^2} = V_0^2 + 2a \frac{x}{x_{\text{flat}}} \]

\[ + \frac{V_0^2}{2M_{kg}} = x \]

\[ \frac{V_0^2}{2M_{kg}} + \frac{x_1 (\sin \theta - \mu \cos \theta)}{M_k} = x \]