5.5

\[ m = 120 \text{kg} \]

\[ F_1 = 32 \quad \theta_1 = 30^\circ \]
\[ F_2 = 55 \]
\[ F_3 = 41 \text{ Newtons} \quad \theta_3 = 60^\circ \]

\[ m \ddot{a} = \sum F \]

\[ F_1 = 32 \cos 30^\circ \hat{i} + 32 \sin 30^\circ \hat{j} \]
\[ F_2 = 55 \hat{i} + 0 \hat{j} \]
\[ F_3 = 41 \cos 60^\circ \hat{i} - 41 \sin 60^\circ \hat{j} \]

\[ F_1 = 27.91 \hat{i} + 16.0 \hat{j} \]
\[ F_2 = 55 \hat{i} + 0 \hat{j} \]
\[ F_3 = 20.50 \hat{i} - 35.51 \hat{j} \]

\[ \bar{F}_{\text{tot}} = 103.2 \hat{i} - 19.51 \hat{j} \]

\[ \ddot{a} = \frac{1}{m} \bar{F}_{\text{tot}} = 0.84 \hat{i} - 0.163 \hat{j} \]

\[ |\ddot{a}| = \sqrt{(0.84)^2 + (-0.163)^2} = 0.875 \text{ m/s}^2 \]

\[ \tan \theta = \frac{-0.163}{0.84} \Rightarrow \theta = -10.7^\circ \]

5.13

4 objects \Rightarrow 4 \text{ fbd}

5.13

Call up the \( y \)-axis
do \( m_a = \sum F_y \) for each fbd
Note that each acceleration is \( = 0 \)

\[ fbd-D \quad fbd-C \quad fbd-B \quad fbd-A \]

\[ T_1 = 58.8 \text{ Newtons} \]
\[ T_2 = 49 \text{ Newtons} \]
\[ T_3 = 9.8 \text{ Newtons} \]

\[ m_{Dg} = T - T_1 - m_{Dg} \]
So that \( m_{Dg} = T - T_1 \)
\[ m_{Bg} = T_1 - T - m_{Bg} \]
\[ m_{Bg} = 9.8 - 58.8 \]
\[ m_{B} = 4 \text{ kg} \]

\[ m_{Dg} = T_2 - T_3 - m_{Dg} \]
\[ m_{Bg} = T_1 - T_2 - m_{Bg} \]
\[ m_{Bg} = 9.8 - 49 \]
\[ m_{B} = 1 \text{ kg} \]

\[ m_{Dg} = T_3 - m_{Dg} \]
\[ m_{Bg} = T_2 - m_{Bg} \]
\[ m_{Bg} = 9.8 - 98 \]
\[ m_{B} = 1 \text{ kg} \]
5.15

Ignore the scale, it is just a tension indicator device.

Pulleys just redirect ropes & tensions

a) \[ T = mg \]
\[ \sum F_y = ma_y \]
\[ T = mg = 11.48 \text{ Newtons} \]

b) \[ T = mg \]
\[ \sum F_y = ma_y \]
\[ T = mg = 11.48 \text{ Newtons} \]

5.26

Weight = 85 Newtons

mg = 85

\[ m(8.3) = 85 \]
\[ m = 8.67 \text{ kg} \]

Assume fish was originally drifting to the left and was stopped from moving at 2.8 m/s. The acceleration vector will point toward Right.

The easiest method to get the magnitude of acceleration is to use the 3rd kinematic formula:
\[ v^2 - v_0^2 = 2a\Delta x \]
\[ 0^2 - 2.8^2 = 2a(-0.11) \]
\[ a = 35.6 \text{ m/s}^2 \]

Then for the fish:

\[ \sum F_x = ma_x \]
\[ \rightarrow T - mg \]

Only worry about horizontal direction.

\[ \sum F_x = ma_x \]
\[ 8.67(35.6) = T \]
\[ T = 309 \text{ Newtons} \]
\[ \approx 70 \text{ lb fishing line} \]
\[ v_0 = 3.5 \text{ m/s} \]

Can get the (de)acceleration from free body analysis, use a tilted coordinate system.

\[
\begin{align*}
\text{max} &= \sum F_x = \sum F_y = 0 \\
\text{max} &= -mg \sin \theta \\
\text{max} &= N - mg \cos \theta
\end{align*}
\]

We just need the \( a_x \):

\[ a_x = -gs \sin \alpha = -9.8 \sin 32^\circ = -5.19 \text{ m/s}^2 \]

\[ a_x = -g \sin \theta = -9.8 \sin 32^\circ = -5.19 \text{ m/s}^2 \]

a) Use the short cut equation:

\[ v_f^2 - v_i^2 = 2a_x \Delta x \]
\[ 0^2 - (3.5)^2 = 2(-5.19) \Delta x \]
\[ \Delta x = 1.18 \text{ m} \]

b) How long:

\[ v_x(t) = v_0 + a_x t \]

at stop:

\[ 0 = 3.5 + (-5.19) t \]
\[ t = 0.674 \text{ sec} \]

c) Since there's no friction, it will be moving at 3.5 m/s.
IDEAL pulleys will adjust and turn until the tension is the same on both sides.

We also need a bent coordinate system because #1 moving up implies #2 moving down.

\[
\begin{align*}
M_1 &= 1.30 \text{ kg} \\
M_2 &= 2.80 \text{ kg} \\
\text{Add equations:} \\
m_1 \times a &= T - m_1g \\
m_2 \times a &= m_2g - T \\
(m_1 + m_2) \times a &= m_2g - m_1g \\
a &= \frac{(m_2 - m_1) \times g}{m_1 + m_2} = \frac{2.8 - 1.3}{1.3 + 2.8} (9.8) = 3.59 \text{ m/s}^2
\end{align*}
\]

Then
\[
\begin{align*}
m_1 \times a &= T - m_1g \\
1.3 (3.59) &= T - 1.3 (9.8) \\
T &= 17.4 \text{ Newtons}
\end{align*}
\]
2 Objects

\[ m_1 = 3.7 \text{ kg} \]
\[ m_2 = 2.3 \text{ kg} \]
\[ \theta = 30^\circ \]

The accelerations are the same. Use a bent co-ordinate system.

\[ \mathbf{F}_x = \sum F_x \]
\[ m_1 a_x = \sum F_x \]
\[ m_1 a_x = T - m_1 g \sin \theta \]
\[ m_2 a_x = m_2 g - T \]

Second estimate his (de)acceleration as he comes to rest.

It's easiest to use:
\[ V_f^2 - V_i^2 = 2a_y \Delta y \]
\[ c^2 - (12.5)^2 = 2a_y (0.02 \text{ m}) \]
\[ a_y = 381 \times 10^3 \text{ m/s}^2 \]

Third estimate forces while stopping:

\[ (m + m_2) a_x = m_2 g - m_1 g \sin \theta \]
\[ a_x = \frac{m_2 g - m_1 g \sin \theta}{m_1 m_2} = \frac{2.3 (9.8) - 3.7 (9.8) \sin 30^\circ}{(3.7 + 2.3)} = \frac{40.67}{6} \]
\[ a_x = 6.68 \text{ m/s}^2 \]

Therefore block B2 accelerates down.

To get tension plug in
\[ m_2 a_x = m_2 g - T \]
\[ 2.3 (6.68) = 2.3 (9.8) - T \]
\[ T = 7.18 \text{ Newtons} \]

5.70

First need speed just as he hits ground
\[ y(t) = y_0 + v_{0y} t + \frac{1}{2} a_y t^2 \]
\[ y_0 = 8 \]
\[ v_{0y} = 0 \]
\[ a_y = 9.8 \]
\[ y = 8 + \frac{1}{2} (9.8) t^2 \]
\[ t = 1.28 \text{ sec} \]
\[ y = 9.8 (1.28) \]
\[ = -17.5 \text{ m/s} \]

mass = 50 kg

\[ V_f = V_{0y} + a_y t \]
\[ V_f = 0 + (9.8) (1.28) \]

\[ V_f = -9.8 (1.28) \]

\[ = -12.5 \text{ m/s} \]