40. Referring to Fig. 5-10(c) is helpful. In this case, viewing the man-rope-sandbag as a system means that we should be careful to choose a consistent positive direction of motion (though there are other ways to proceed – say, starting with individual application of Newton's law to each mass). We take *down* as positive for the man's motion and *up* as positive for the sandbag's motion and, without ambiguity, denote their acceleration as a. The net force on the system is the difference between the weight of the man and that of the sandbag. The system mass is $m_{\text{sys}} = 85 + 65 = 150$ kg. Thus, Eq. 5-1 leads to

$$(85)(9.8) - (65)(9.8) = m_{\text{sys}}\, a$$

which yields $a = 1.3$ m/s^2. Since the system starts from rest, Eq. 2-16 determines the speed (after traveling $\Delta y = 10$ m) as follows:

$$v = \sqrt{2a\Delta y} = \sqrt{2(1.3)(10)} = 5.1 \text{ m/s} .$$

50. The motion of the man-and-chair is positive if upward.

(a) When the man is grasping the rope, pulling with a force equal to the tension T in the rope, the total upward force on the man-and-chair due its two contact points with the rope is $2T$. Thus, Newton's second law leads to

$$2T - mg = ma$$

so that when $a = 0$, the tension is $T = 466$ N.

(b) When $a = +1.3 \text{ m/s}^2$ the equation in part (a) predicts that the tension will be $T = 527$ N.

(c) When the man is not holding the rope (instead, the co-worker attached to the ground is pulling on the rope with a force equal to the tension T in it), there is only one contact point between the rope and the man-and-chair, and Newton's second law now leads to

$$T - mg = ma$$

so that when $a = 0$, the tension is $T = 931$ N.

(d) When $a = +1.3 \text{ m/s}^2$ the equation in part (c) predicts that the tension will be $T = 1.05 \times 10^3$ N.

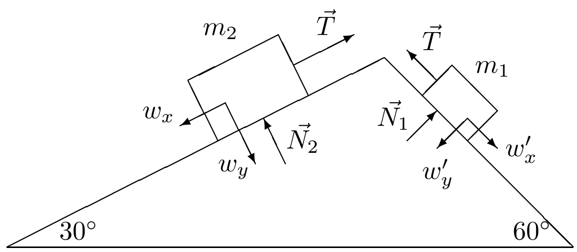
(e) The rope comes into contact (pulling down in each case) at the left edge and the right edge of the pulley, producing a total downward force of magnitude $2T$ on the ceiling. Thus, in part (a) this gives $2T = 931$ N.

(f) In part (b) the downward force on the ceiling has magnitude $2T = 1.05 \times 10^3$ N.

(g) In part (c) the downward force on the ceiling has magnitude $2T = 1.86 \times 10^3$ N.

(h) In part (d) the downward force on the ceiling has magnitude $2T = 2.11 \times 10^3$ N.

58. For convenience, we have labeled the 2.0 kg box m_1 and the 3.0 kg box m_2 – and their weights w' and w, respectively. The $+x$ axis is "downhill" for m_1 and "uphill" for m_2 (so they both accelerate with the same sign).



We apply Newton's second law to each box's x axis:

$$\begin{aligned} m_1 g \sin 60° - T &= m_1 a \\ T - m_2 g \sin 30° &= m_2 a \end{aligned}$$

Adding the two equations allows us to solve for the acceleration $a = 0.45 \text{ m/s}^2$. This value is plugged back into either of the two equations to yield the tension $T = 16$ N.

62. Making separate free-body diagrams for the helicopter and the truck, one finds there are two forces on the truck ($\vec{T}$ upward, caused by the tension, which we'll think of as that of a single cable, and $m\vec{g}$ downward, where $m = 4500$ kg) and three forces on the helicopter ($\vec{T}$ downward, $\vec{F}_{\text{lift}}$ upward, and $M\vec{g}$ downward, where $M = 15000$ kg). With $+y$ upward, then $a = +1.4$ m/s^2 for both the helicopter and the truck.

(a) Newton's law applied to the helicopter and truck separately gives

$$\begin{aligned} F_{\text{lift}} - T - Mg &= Ma \\ T - mg &= ma \end{aligned}$$

which we add together to obtain

$$F_{\text{lift}} - (M + m)g = (M + m)a \; .$$

From this equation, we find $F_{\text{lift}} = 2.2 \times 10^5$ N.

(b) From the truck equation $T - mg = ma$ we obtain $T = 5.0 \times 10^4$ N.