42. The direction of motion (the direction of the barge's acceleration) is $+\hat{\mathrm{i}}$, and $+\vec{\mathrm{j}}$ is chosen so that the pull $\vec{F}_{\mathrm{h}}$ from the horse is in the first quadrant. The components of the unknown force of the water are denoted simply F_x and F_y.

(a) Newton's second law applied to the barge, in the x and y directions, leads to

$$\begin{aligned}(7900\,\mathrm{N})\cos 18° + F_x &= ma \\ (7900\,\mathrm{N})\sin 18° + F_y &= 0\end{aligned}$$

respectively. Plugging in a = 0.12 m/s^2 and m = 9500 kg, we obtain F_x = $-$ 6.4 × 10^3 N and F_y = $-$ 2.4 × 10^3 N. The magnitude of the force of the water is therefore

$$F_{\mathrm{water}} = \sqrt{F_x^2 + F_y^2} = 6.8 \times 10^3 \ \mathrm{N}.$$

(b) Its angle measured from $+\hat{\mathrm{i}}$ is either

$$\tan^{-1}\left(\frac{F_y}{F_x}\right) = +21° \,\mathrm{or}\, 201°.$$

The signs of the components indicate the latter is correct, so $\vec{F}_{\mathrm{water}}$ is at 201° measured counterclockwise from the line of motion (+x axis).

44. (a) The term "deceleration" means the acceleration vector is in the direction opposite to the velocity vector (which the problem tells us is downward). Thus (with +y upward) the acceleration is a = +2.4 m/s^2. Newton's second law leads to

$$T - mg = ma \ \Rightarrow \ m = \frac{T}{g + a}$$

which yields m = 7.3 kg for the mass.

(b) Repeating the above computation (now to solve for the tension) with a = +2.4 m/s^2 will, of course, lead us right back to T = 89 N. Since the direction of the velocity did not enter our computation, this is to be expected.

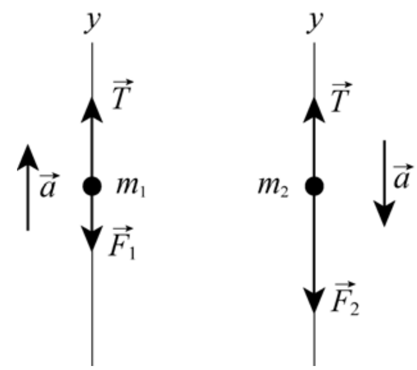
51. The free-body diagrams for m_1 and m_2 are shown in the figures below. The only forces on the blocks are the upward tension $\vec{T}$ and the downward gravitational forces $\vec{F}_1 = m_1 g$ and $\vec{F}_2 = m_2 g$. Applying Newton's second law, we obtain:

$$T - m_1 g = m_1 a$$

$$m_2 g - T = m_2 a$$

which can be solved to yield

$$a = \left(\frac{m_2 - m_1}{m_2 + m_1} \right) g$$



Substituting the result back, we have

$$T = \left(\frac{2m_1 m_2}{m_1 + m_2} \right) g$$

(a) With $m_1 = 1.3$ kg and $m_2 = 2.8$ kg, the acceleration becomes

$$a = \left(\frac{2.80\,\text{kg} - 1.30\,\text{kg}}{2.80\,\text{kg} + 1.30\,\text{kg}} \right)(9.80\,\text{m/s}^2) = 3.59\ \text{m/s}^2 \approx 3.6\ \text{m/s}^2.$$

(b) Similarly, the tension in the cord is

$$T = \frac{2(1.30\,\text{kg})(2.80\,\text{kg})}{1.30\,\text{kg} + 2.80\,\text{kg}}(9.80\,\text{m/s}^2) = 17.4\ \text{N} \approx 17\ \text{N}.$$

53. We apply Newton's second law first to the three blocks as a single system and then to the individual blocks. The $+x$ direction is to the right in Fig. 5-48.

(a) With $m_{sys} = m_1 + m_2 + m_3 = 67.0$ kg, we apply Eq. 5-2 to the x motion of the system, in which case, there is only one force $\vec{T}_3 = +\vec{T}_3\ \hat{\text{i}}$. Therefore,

$$T_3 = m_{sys} a \quad \Rightarrow \quad 65.0\,\text{N} = (67.0\,\text{kg})a$$

which yields $a = 0.970$ m/s^2 for the system (and for each of the blocks individually).

(b) Applying Eq. 5-2 to block 1, we find

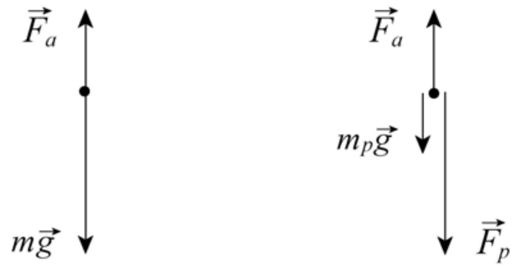
$$T_1 = m_1 a = (12.0\,\text{kg})(0.970\,\text{m/s}^2) = 11.6\,\text{N}.$$

(c) In order to find T_2, we can either analyze the forces on block 3 or we can treat blocks 1 and 2 as a system and examine its forces. We choose the latter.

$$T_2 = (m_1 + m_2)a = (12.0\text{ kg} + 24.0\text{ kg})(0.970\text{ m/s}^2) = 34.9\text{ N}.$$

80. We take down to be the $+y$ direction.

(a) The first diagram (shown below left) is the free-body diagram for the person and parachute, considered as a single object with a mass of 80 kg + 5.0 kg = 85 kg.



$\vec{F}_a$ is the force of the air on the parachute and $m\vec{g}$ is the force of gravity. Application of Newton's second law produces $mg - F_a = ma$, where a is the acceleration. Solving for F_a we find

$$F_a = m(g - a) = (85\text{ kg})(9.8\text{ m/s}^2 - 2.5\text{ m/s}^2) = 620\text{ N}.$$

(b) The second diagram (above right) is the free-body diagram for the parachute alone. $\vec{F}_a$ is the force of the air, $m_p\vec{g}$ is the force of gravity, and $\vec{F}_p$ is the force of the person. Now, Newton's second law leads to

$$m_p g + F_p - F_a = m_p a.$$

Solving for F_p, we obtain

$$F_p = m_p(a - g) + F_a = (5.0\text{ kg})(2.5\text{ m/s}^2 - 9.8\text{ m/s}^2) + 620\text{ N} = 580\text{ N}.$$