Chapter 5

1. We apply Newton's second law (specifically, Eq. 5-2).

(a) We find the x component of the force is

$$F_x = ma_x = ma\cos 20.0° = (1.00\,\text{kg})\left(2.00\,\text{m/s}^2\right)\cos 20.0° = 1.88\,\text{N}.$$

(b) The y component of the force is

$$F_y = ma_y = ma\sin 20.0° = (1.0\,\text{kg})\left(2.00\,\text{m/s}^2\right)\sin 20.0° = 0.684\,\text{N}.$$

(c) In unit-vector notation, the force vector is

$$\vec{F} = F_x\hat{\text{i}} + F_y\hat{\text{j}} = (1.88\text{ N})\hat{\text{i}} + (0.684\text{ N})\hat{\text{j}}\,.$$

2. We apply Newton's second law (Eq. 5-1 or, equivalently, Eq. 5-2). The net force applied on the chopping block is $\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2$, where the vector addition is done using unit-vector notation. The acceleration of the block is given by $\vec{a} = \left(\vec{F}_1 + \vec{F}_2\right)/m$.

(a) In the first case

$$\vec{F}_1 + \vec{F}_2 = \left[(3.0\text{N})\hat{\text{i}} + (4.0\text{N})\hat{\text{j}}\right] + \left[(-3.0\text{N})\hat{\text{i}} + (-4.0\text{N})\hat{\text{j}}\right] = 0$$

so $\vec{a} = 0$.

(b) In the second case, the acceleration $\vec{a}$ equals

$$\frac{\vec{F}_1 + \vec{F}_2}{m} = \frac{\left((3.0\text{N})\hat{\text{i}} + (4.0\text{N})\hat{\text{j}}\right) + \left((-3.0\text{N})\hat{\text{i}} + (4.0\text{N})\hat{\text{j}}\right)}{2.0\,\text{kg}} = (4.0\,\text{m/s}^2)\hat{\text{j}}.$$

(c) In this final situation, $\vec{a}$ is

$$\frac{\vec{F}_1 + \vec{F}_2}{m} = \frac{\left((3.0\text{N})\hat{\text{i}} + (4.0\text{N})\hat{\text{j}}\right) + \left((3.0\text{N})\hat{\text{i}} + (-4.0\text{N})\hat{\text{j}}\right)}{2.0\text{ kg}} = (3.0\,\text{m/s}^2)\hat{\text{i}}.$$

5. We denote the two forces $\vec{F}_1$ and $\vec{F}_2$. According to Newton's second law, $\vec{F}_1 + \vec{F}_2 = m\vec{a}$, so $\vec{F}_2 = m\vec{a} - \vec{F}_1$.

(a) In unit vector notation $\vec{F}_1 = (20.0\text{ N})\hat{\text{i}}$ and

$$\vec{a} = -\left(12.0 \sin 30.0° \text{ m/s}^2\right)\hat{\text{i}} - \left(12.0 \cos 30.0° \text{ m/s}^2\right)\hat{\text{j}} = -\left(6.00 \text{ m/s}^2\right)\hat{\text{i}} - \left(10.4 \text{m/s}^2\right)\hat{\text{j}}.$$

Therefore,

$$\begin{aligned}\vec{F}_2 &= \left(2.00 \text{kg}\right)\left(-6.00 \text{ m/s}^2\right)\hat{\text{i}} + \left(2.00 \text{ kg}\right)\left(-10.4 \text{ m/s}^2\right)\hat{\text{j}} - \left(20.0 \text{ N}\right)\hat{\text{i}} \\ &= \left(-32.0 \text{ N}\right)\hat{\text{i}} - \left(20.8 \text{ N}\right)\hat{\text{j}}.\end{aligned}$$

(b) The magnitude of $\vec{F}_2$ is

$$|\vec{F}_2| = \sqrt{F_{2x}^2 + F_{2y}^2} = \sqrt{(-32.0 \text{ N})^2 + (-20.8 \text{ N})^2} = 38.2 \text{ N}.$$

(c) The angle that $\vec{F}_2$ makes with the positive x axis is found from

$$\tan\theta = (F_{2y}/F_{2x}) = [(-20.8 \text{ N})/(-32.0 \text{ N})] = 0.656.$$

Consequently, the angle is either 33.0° or 33.0° + 180° = 213°. Since both the x and y components are negative, the correct result is 213°. An alternative answer is $213° - 360° = -147°$.

8. Since the tire remains stationary, by Newton's second law, the net force must be zero:

$$\vec{F}_{\text{net}} = \vec{F}_A + \vec{F}_B + \vec{F}_C = m\vec{a} = 0.$$

From the free-body diagram shown on the right, we have

$$\begin{aligned}0 &= \sum F_{\text{net},x} = F_C \cos\phi - F_A \cos\theta \\ 0 &= \sum F_{\text{net},y} = F_A \sin\theta + F_C \sin\phi - F_B\end{aligned}$$

To solve for F_B, we first compute ϕ. With $F_A = 220 \text{ N}$, $F_C = 170 \text{ N}$ and $\theta = 47°$, we get

$$\cos\phi = \frac{F_A \cos\theta}{F_C} = \frac{(220 \text{ N}) \cos 47.0°}{170 \text{ N}} = 0.883 \quad \Rightarrow \phi = 28.0°$$

Substituting the value into the second force equation, we find

$$F_B = F_A \sin\theta + F_C \sin\phi = (220 \text{ N}) \sin 47.0° + (170 \text{ N}) \sin 28.0 = 241 \text{ N}.$$

9. The velocity is the derivative (with respect to time) of given function x, and the acceleration is the derivative of the velocity. Thus, $a = 2c - 3(2.0)(2.0)t$, which we use in Newton's second law: $F = (2.0 \text{ kg})a = 4.0c - 24t$ (with SI units understood). At $t = 3.0$ s,

we are told that $F = -36$ N. Thus, $-36 = 4.0c - 24(3.0)$ can be used to solve for c. The result is $c = +9.0 \text{ m/s}^2$.

10. To solve the problem, we note that acceleration is the second time derivative of the position function, and the net force is related to the acceleration via Newton's second law. Thus, differentiating

$$x(t) = -13.00 + 2.00t + 4.00t^2 - 3.00t^3$$

twice with respect to t, we get

$$\frac{dx}{dt} = 2.00 + 8.00t - 9.00t^2, \quad \frac{d^2x}{dt^2} = 8.00 - 18.0t$$

The net force acting on the particle at $t = 3.40$ s is

$$\vec{F} = m\frac{d^2x}{dt^2}\hat{\text{i}} = (0.150)\left[8.00 - 18.0(3.40)\right]\hat{\text{i}} = (-7.98 \text{ N})\hat{\text{i}}$$

13. (a) – (c) In all three cases the scale is not accelerating, which means that the two cords exert forces of equal magnitude on it. The scale reads the magnitude of either of these forces. In each case the tension force of the cord attached to the salami must be the same in magnitude as the weight of the salami because the salami is not accelerating. Thus the scale reading is mg, where m is the mass of the salami. Its value is (11.0 kg) (9.8 m/s^2) = 108 N.

19. (a) Since the acceleration of the block is zero, the components of the Newton's second law equation yield

$$T - mg \sin\theta = 0$$
$$F_N - mg \cos\theta = 0.$$

Solving the first equation for the tension in the string, we find

$$T = mg\sin\theta = (8.5 \text{ kg})(9.8 \text{ m/s}^2) \sin 30° = 42 \text{ N}.$$

(b) We solve the second equation in part (a) for the normal force F_N:

$$F_N = mg\cos\theta = (8.5 \text{ kg})(9.8 \text{ m/s}^2) \cos 30° = 72 \text{ N}.$$

(c) When the string is cut, it no longer exerts a force on the block and the block accelerates. The x component of the second law becomes $-mg\sin\theta = ma$, so the acceleration becomes

$$a = -g \sin\theta = -(9.8 \text{ m/s}^2)\sin 30° = -4.9 \text{ m/s}^2.$$

The negative sign indicates the acceleration is down the plane. The magnitude of the acceleration is 4.9 m/s^2.

23. (a) The acceleration is

$$a = \frac{F}{m} = \frac{20\text{ N}}{900\,\text{kg}} = 0.022\ \text{m/s}^2\ .$$

(b) The distance traveled in 1 day (= 86400 s) is

$$s = \frac{1}{2}at^2 = \frac{1}{2}\left(0.0222\,\text{m/s}^2\right)\left(86400\,\text{s}\right)^2 = 8.3 \times 10^7\ \text{m}\ .$$

(c) The speed it will be traveling is given by

$$v = at = \left(0.0222\ \text{m/s}^2\right)\left(86400\ \text{s}\right) = 1.9 \times 10^3\ \text{m/s}\ .$$

26. The stopping force $\vec{F}$ and the path of the passenger are horizontal. Our +*x* axis is in the direction of the passenger's motion, so that the passenger's acceleration (''deceleration") is negative-valued and the stopping force is in the –*x* direction: $\vec{F} = -F\,\hat{\text{i}}$. Using Eq. 2-16 with

$$v_0 = (53\text{ km/h})(1000\text{ m/km})/(3600\text{ s/h}) = 14.7\text{ m/s}$$

and $v = 0$, the acceleration is found to be

$$v^2 = v_0^2 + 2a\Delta x \quad\Rightarrow\quad a = -\frac{v_0^2}{2\Delta x} = -\frac{(14.7\text{ m/s})^2}{2\left(0.65\text{ m}\right)} = -167\ \text{m/s}^2\,.$$

Assuming there are no significant horizontal forces other than the stopping force, Eq. 5-1 leads to

$$\vec{F} = m\vec{a} \quad\Rightarrow\quad -F = \left(41\text{ kg}\right)\left(-167\,\text{m/s}^2\right)$$

which results in $F = 6.8 \times 10^3$ N.

27. We choose up as the +*y* direction, so $\vec{a} = (-3.00\,\text{m/s}^2)\hat{\text{j}}$ (which, without the unit-vector, we denote as *a* since this is a 1-dimensional problem in which Table 2-1 applies). From Eq. 5-12, we obtain the firefighter's mass: $m = W/g = 72.7$ kg.

(a) We denote the force exerted by the pole on the firefighter $\vec{F}_{\text{fp}} = F_{\text{fp}}\ \hat{\text{j}}$ and apply Eq. 5-1. Since $\vec{F}_{\text{net}} = m\vec{a}$, we have

$$F_{\text{fp}} - F_g = ma \quad\Rightarrow\quad F_{\text{fp}} - 712\text{ N} = (72.7\text{ kg})(-3.00\text{ m/s}^2)$$

which yields F_{fp} = 494 N.

(b) The fact that the result is positive means $\vec{F}_{fp}$ points up.

(c) Newton's third law indicates $\vec{F}_{fp} = -\vec{F}_{pf}$, which leads to the conclusion that $|\vec{F}_{pf}| = 494\ \text{N}$.

(d) The direction of $\vec{F}_{pf}$ is down.

35. The free-body diagram is shown next. $\vec{F}_N$ is the normal force of the plane on the block and $m\vec{g}$ is the force of gravity on the block. We take the +x direction to be down the incline, in the direction of the acceleration, and the +y direction to be in the direction of the normal force exerted by the incline on the block. The x component of Newton's second law is then $mg \sin\theta = ma$; thus, the acceleration is $a = g \sin\theta$.

(a) Placing the origin at the bottom of the plane, the kinematic equations (Table 2-1) for motion along the x axis which we will use are $v^2 = v_0^2 + 2ax$ and $v = v_0 + at$. The block momentarily stops at its highest point, where v = 0; according to the second equation, this occurs at time $t = -v_0/a$. The position where it stops is

$$x = -\frac{1}{2}\frac{v_0^2}{a} = -\frac{1}{2}\left(\frac{(-3.50\ \text{m/s})^2}{(9.8\ \text{m/s}^2)\sin 32.0°}\right) = -1.18\ \text{m},$$

or $|x| = 1.18$ m.

(b) The time is

$$t = \frac{v_0}{a} = -\frac{v_0}{g\sin\theta} = -\frac{-3.50\,\text{m/s}}{(9.8\,\text{m/s}^2)\sin 32.0°} = 0.674\,\text{s}.$$

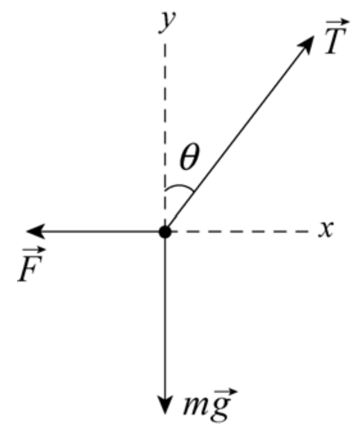
(c) That the return-speed is identical to the initial speed is to be expected since there are no dissipative forces in this problem. In order to prove this, one approach is to set x = 0 and solve $x = v_0 t + \frac{1}{2}at^2$ for the total time (up and back down) t. The result is

$$t = -\frac{2v_0}{a} = -\frac{2v_0}{g\sin\theta} = -\frac{2(-3.50\ \text{m/s})}{(9.8\ \text{m/s}^2)\sin 32.0°} = 1.35\ \text{s}.$$

The velocity when it returns is therefore

$$v = v_0 + at = v_0 + gt \sin\theta = -3.50 \text{ m/s} + (9.8 \text{ m/s}^2)(1.35 \text{ s}) \sin 32° = 3.50 \text{ m/s}.$$

37. The solutions to parts (a) and (b) have been combined here. The free-body diagram is shown below, with the tension of the string $\vec{T}$, the force of gravity $m\vec{g}$, and the force of the air $\vec{F}$. Our coordinate system is shown. Since the sphere is motionless the net force on it is zero, and the x and the y components of the equations are:



$$T \sin\theta - F = 0$$
$$T \cos\theta - mg = 0,$$

where $\theta = 37°$. We answer the questions in the reverse order. Solving $T \cos\theta - mg = 0$ for the tension, we obtain

$$T = mg / \cos\theta = (3.0 \times 10^{-4} \text{ kg})\,(9.8 \text{ m/s}^2) / \cos 37° = 3.7 \times 10^{-3} \text{ N}.$$

Solving $T \sin\theta - F = 0$ for the force of the air:

$$F = T \sin\theta = (3.7 \times 10^{-3} \text{ N}) \sin 37° = 2.2 \times 10^{-3} \text{ N}.$$

42. (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 $a = +2.4 \text{ m/s}^2$. Newton's second law leads to

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

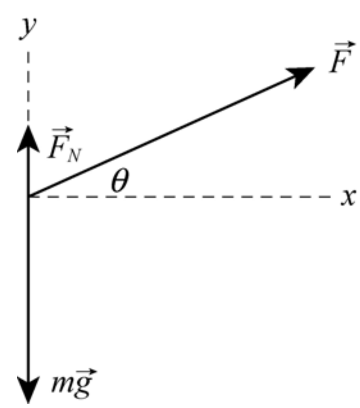
which yields $m = 7.3$ kg for the mass.

(b) Repeating the above computation (now to solve for the tension) with $a = +2.4 \text{ m/s}^2$ 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.

47. The free-body diagram (not to scale) for the block is shown below. $\vec{F}_N$ is the normal force exerted by the floor and $m\vec{g}$ is the force of gravity.

(a) The x component of Newton's second law is $F \cos\theta = ma$, where m is the mass of the block and a is the x component of its acceleration. We obtain

$$a = \frac{F\cos\theta}{m} = \frac{(12.0 \text{ N})\cos 25.0°}{5.00 \text{ kg}} = 2.18 \text{ m/s}^2.$$



This is its acceleration provided it remains in contact with the floor. Assuming it does, we find the value of F_N (and if F_N is positive, then the assumption is true but if F_N is negative then the block leaves the floor). The y component of Newton's second law becomes

$$F_N + F\sin\theta - mg = 0,$$

so

$$F_N = mg - F\sin\theta = (5.00\text{ kg})(9.80\text{ m/s}^2) - (12.0\text{ N})\sin 25.0° = 43.9\text{ N}.$$

Hence the block remains on the floor and its acceleration is $a = 2.18\text{ m/s}^2$.

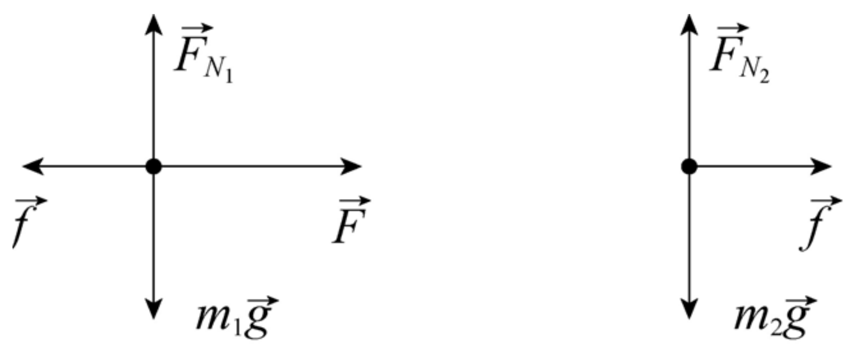
(b) If F is the minimum force for which the block leaves the floor, then $F_N = 0$ and the y component of the acceleration vanishes. The y component of the second law becomes

$$F\sin\theta - mg = 0 \quad\Rightarrow\quad F = \frac{mg}{\sin\theta} = \frac{(5.00\text{ kg})(9.80\text{ m/s}^2)}{\sin 25.0°} = 116\text{ N}.$$

(c) The acceleration is still in the x direction and is still given by the equation developed in part (a):

$$a = \frac{F\cos\theta}{m} = \frac{(116\text{ N})\cos 25.0°}{5.00\text{ kg}} = 21.0\text{ m/s}^2.$$

53. The free-body diagrams for part (a) are shown below. $\vec{F}$ is the applied force and $\vec{f}$ is the force exerted by block 1 on block 2. We note that $\vec{F}$ is applied directly to block 1 and that block 2 exerts the force $-\vec{f}$ on block 1 (taking Newton's third law into account).



(a) Newton's second law for block 1 is $F - f = m_1a$, where a is the acceleration. The second law for block 2 is $f = m_2a$. Since the blocks move together they have the same acceleration and the same symbol is used in both equations. From the second equation we obtain the expression $a = f/m_2$, which we substitute into the first equation to get $F - f = m_1f/m_2$. Therefore,

$$f = \frac{Fm_2}{m_1 + m_2} = \frac{(3.2 \text{ N})(1.2 \text{ kg})}{2.3 \text{ kg} + 1.2 \text{ kg}} = 1.1 \text{ N} .$$

(b) If $\vec{F}$ is applied to block 2 instead of block 1 (and in the opposite direction), the force of contact between the blocks is

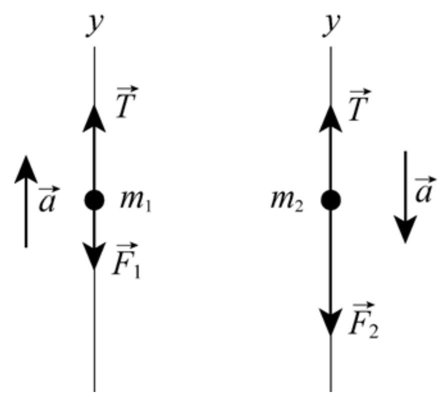
$$f = \frac{Fm_1}{m_1 + m_2} = \frac{(3.2 \text{ N})(2.3 \text{ kg})}{2.3 \text{ kg} + 1.2 \text{ kg}} = 2.1 \text{ N} .$$

(c) We note that the acceleration of the blocks is the same in the two cases. In part (a), the force f is the only horizontal force on the block of mass m_2 and in part (b) f is the only horizontal force on the block with $m_1 > m_2$. Since $f = m_2a$ in part (a) and $f = m_1a$ in part (b), then for the accelerations to be the same, f must be larger in part (b).

55. 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

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

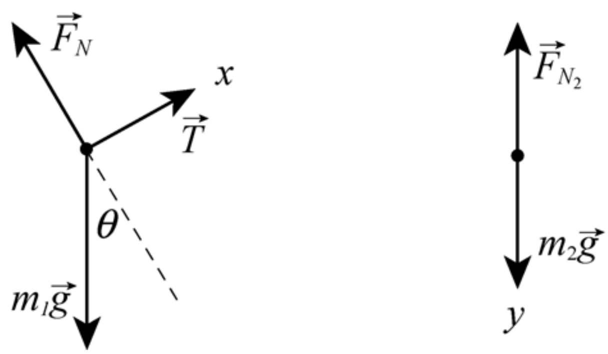
(b) Similarly, the tension in the cord is

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

59. The free-body diagram for each block is shown below. T is the tension in the cord and θ = 30° is the angle of the incline. For block 1, we take the +x direction to be up the incline and the +y direction to be in the direction of the normal force $\vec{F}_N$ that the plane exerts on the block. For block 2, we take the +y direction to be down. In this way, the accelerations of the two blocks can be represented by the same symbol a, without ambiguity. Applying Newton's second law to the x and y axes for block 1 and to the y axis of block 2, we obtain

$$T - m_1 g \sin\theta = m_1 a$$
$$F_N - m_1 g \cos\theta = 0$$
$$m_2 g - T = m_2 a$$

respectively. The first and third of these equations provide a simultaneous set for obtaining values of a and T. The second equation is not needed in this problem, since the normal force is neither asked for nor is it needed as part of some further computation (such as can occur in formulas for friction).



(a) We add the first and third equations above:

$$m_2 g - m_1 g \sin\theta = m_1 a + m_2 a.$$

Consequently, we find

$$a = \frac{(m_2 - m_1 \sin\theta)g}{m_1 + m_2} = \frac{[2.30\text{ kg} - (3.70\text{ kg})\sin 30.0°](9.80\text{ m/s}^2)}{3.70\text{ kg} + 2.30\text{ kg}} = 0.735\,\text{m/s}^2.$$

(b) The result for a is positive, indicating that the acceleration of block 1 is indeed up the incline and that the acceleration of block 2 is vertically down.

(c) The tension in the cord is

$$T = m_1 a + m_1 g \sin\theta = (3.70\text{ kg})(0.735\text{ m/s}^2) + (3.70\text{ kg})(9.80\text{ m/s}^2)\sin 30.0° = 20.8\,\text{N}.$$

65. First we analyze the entire *system* with "clockwise" motion considered positive (that is, downward is positive for block C, rightward is positive for block B, and upward is positive for block A): $m_C g - m_A g = Ma$ (where M = mass of the *system* = 24.0 kg). This yields an acceleration of

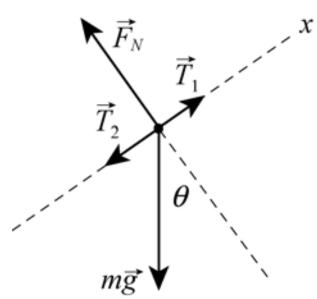
$$a = g(m_C - m_A)/M = 1.63 \text{ m/s}^2.$$

Next we analyze the forces just on block C: $m_C g - T = m_C a$. Thus the tension is

$$T = m_C g(2m_A + m_B)/M = 81.7 \text{ N}.$$

67. (a) The acceleration (which equals F/m in this problem) is the derivative of the velocity. Thus, the velocity is the integral of F/m, so we find the "area" in the graph (15 units) and divide by the mass (3) to obtain $v - v_o = 15/3 = 5$. Since $v_o = 3.0$ m/s, then $v = 8.0\,\text{m/s}$.

(b) Our positive answer in part (a) implies $\vec{v}$ points in the $+x$ direction.



73. Although the full specification of $\vec{F}_{\text{net}} = m\vec{a}$ in this situation involves both x and y axes, only the x-application is needed to find what this particular problem asks for. We note that $a_y = 0$ so that there is no ambiguity denoting a_x simply as a. We choose $+x$ to the right and $+y$ up. We also note that the x component of the rope's tension (acting on the crate) is

$$F_x = F\cos\theta = (450 \text{ N}) \cos 38° = 355 \text{ N},$$

and the resistive force (pointing in the $-x$ direction) has magnitude $f = 125$ N.

(a) Newton's second law leads to

$$F_x - f = ma \Rightarrow a = \frac{355 \text{ N} - 125 \text{ N}}{310 \text{ kg}} = 0.74\,\text{m/s}^2.$$

(b) In this case, we use Eq. 5-12 to find the mass: $m = W/g = 31.6$ kg. Now, Newton's second law leads to

$$T_x - f = ma \;\Rightarrow\; a = \frac{355 \text{ N} - 125 \text{ N}}{31.6 \text{ kg}} = 7.3 \text{ m/s}^2 .$$

75. (a) Since the performer's weight is (52 kg)(9.8 m/s^2) = 510 N, the rope breaks.

(b) Setting $T = 425$ N in Newton's second law (with $+y$ upward) leads to

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

which yields $|a| = 1.6$ m/s^2.

80. We use the notation g as the acceleration due to gravity near the surface of Callisto, m as the mass of the landing craft, a as the acceleration of the landing craft, and F as the rocket thrust. We take down to be the positive direction. Thus, Newton's second law takes the form $mg - F = ma$. If the thrust is F_1 (= 3260 N), then the acceleration is zero, so $mg - F_1 = 0$. If the thrust is F_2 (= 2200 N), then the acceleration is a_2 (= 0.39 m/s^2), so $mg - F_2 = ma_2$.

(a) The first equation gives the weight of the landing craft: $mg = F_1 = 3260$ N.

(b) The second equation gives the mass:

$$m = \frac{mg - F_2}{a_2} = \frac{3260 \text{ N} - 2200 \text{ N}}{0.39 \text{ m/s}^2} = 2.7 \times 10^3 \text{ kg} .$$

(c) The weight divided by the mass gives the acceleration due to gravity:

$$g = (3260 \text{ N})/(2.7 \times 10^3 \text{ kg}) = 1.2 \text{ m/s}^2.$$

81. From the reading when the elevator was at rest, we know the mass of the object is m = (65 N)/(9.8 m/s^2) = 6.6 kg. We choose $+y$ upward and note there are two forces on the object: mg downward and T upward (in the cord that connects it to the balance; T is the reading on the scale by Newton's third law).

(a) "Upward at constant speed" means constant velocity, which means no acceleration. Thus, the situation is just as it was at rest: $T = 65$ N.

(b) The term "deceleration" is used when the acceleration vector points in the direction opposite to the velocity vector. We're told the velocity is upward, so the acceleration vector points downward ($a = -2.4$ m/s^2). Newton's second law gives

$$T - mg = ma \Rightarrow T = (6.6 \text{ kg})(9.8 \text{ m/s}^2 - 2.4 \text{ m/s}^2) = 49 \text{ N}.$$

84. We use $W_p = mg_p$, where W_p is the weight of an object of mass m on the surface of a certain planet p, and g_p is the acceleration of gravity on that planet.

(a) The weight of the space ranger on Earth is

$$W_e = mg_e = (75 \text{ kg})\ (9.8 \text{ m/s}^2) = 7.4 \times 10^2 \text{ N}.$$

(b) The weight of the space ranger on Mars is

$$W_m = mg_m = (75\text{ kg})\,(3.7\text{ m/s}^2) = 2.8 \times 10^2\text{ N}.$$

(c) The weight of the space ranger in interplanetary space is zero, where the effects of gravity are negligible.

(d) The mass of the space ranger remains the same, m=75 kg, at all the locations.

87. (a) Intuition readily leads to the conclusion that the heavier block should be the hanging one, for largest acceleration. The force that “drives” the system into motion is the weight of the hanging block (gravity acting on the block on the table has no effect on the dynamics, so long as we ignore friction). Thus, m = 4.0 kg.

The acceleration of the system and the tension in the cord can be readily obtained by solving

$$mg - T = ma$$
$$T = Ma.$$

(b) The acceleration is given by

$$a = \left(\frac{m}{m + M}\right) g = 6.5\text{ m/s}^2.$$

(c) The tension is

$$T = Ma = \left(\frac{Mm}{m + M}\right) g = 13\text{ N}.$$