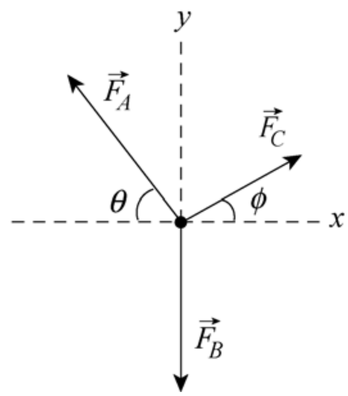
6. Since the tire remains stationary, by Newton's second law, the net force must be zero:

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

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




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

To solve for $F_B$, we first compute $\phi$. With $F_A = 220$ N, $F_C = 170$ 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

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

13. (a) From the fact that $T_3$ = 9.8 N, we conclude the mass of disk *D* is 1.0 kg. Both this and that of disk *C* cause the tension $T_2$ = 49 N, which allows us to conclude that disk *C* has a mass of 4.0 kg. The weights of these two disks plus that of disk *B* determine the tension $T_1$ = 58.8 N, which leads to the conclusion that $m_B$ = 1.0 kg. The weights of all the disks must add to the 98 N force described in the problem; therefore, disk *A* has mass 4.0 kg.

(b) $m_B$ = 1.0 kg, as found in part (a).

(c) $m_C$ = 4.0 kg, as found in part (a).

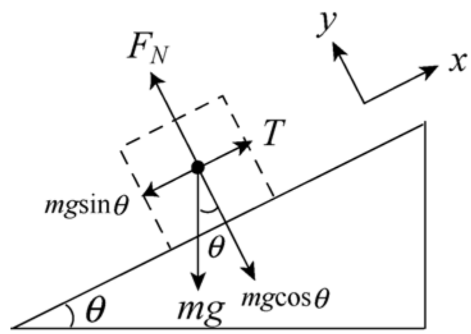
(d) $m_D$ = 1.0 kg, as found in part (a).

17. **THINK** A block attached to a cord is resting on an incline plane. We apply Newton's second law to solve for the tension in the cord and the normal force on the block.

**EXPRESS** The free-body diagram of the problem is shown to the right. Since the acceleration of the block is zero, the components of Newton's second law equation yield

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

where $T$ is the tension in the cord, and $F_N$ is the normal force on the block.




**ANALYZE** (a) 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 above 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 cord 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$^2$.

**LEARN** The normal force $F_N$ on the block must be equal to $mg\cos\theta$ so that the block is in contact with the surface of the incline at all time. When the cord is cut, the block has an acceleration $a = -g\sin\theta$, which in the limit $\theta \to 90°$ becomes $-g$, as in the case of a free fall.

33. The free-body diagram is shown below. Let $\vec{T}$ be the tension of the cable and $m\vec{g}$ be the force of gravity. If the upward direction is positive, then Newton's second law is $T - mg = ma$, where $a$ is the acceleration.

Thus, the tension is $T = m(g + a)$. We use constant acceleration kinematics (Table 2-1) to find the acceleration (where $v = 0$ is the final velocity, $v_0 = -12$ m/s is the initial velocity, and $y = -42$ m is the coordinate at the stopping point). Consequently, $v^2 = v_0^2 + 2ay$ leads to

$$a = -\frac{v_0^2}{2y} = -\frac{(-12\ \text{m/s})^2}{2(-42\ \text{m})} = 1.71\ \text{m/s}^2 .$$

We now return to calculate the tension:

$$\begin{aligned} T &= m(g + a) \\ &= (1600\ \text{kg})\left(9.8\ \text{m/s}^2 + 1.71\ \text{m/s}^2\right) \\ &= 1.8 \times 10^4\ \text{N} . \end{aligned}$$


37. (a) Since friction is negligible the force of the girl is the only horizontal force on the sled. The vertical forces (the force of gravity and the normal force of the ice) sum to zero. The acceleration of the sled is

$$a_s = \frac{F}{m_s} = \frac{5.2\ \text{N}}{8.4\ \text{kg}} = 0.62\ \text{m/s}^2 .$$

(b) According to Newton's third law, the force of the sled on the girl is also 5.2 N. Her acceleration is

$$a_g = \frac{F}{m_g} = \frac{5.2\ \text{N}}{40\ \text{kg}} = 0.13\ \text{m/s}^2 .$$

(c) The accelerations of the sled and girl are in opposite directions. Assuming the girl starts at the origin and moves in the $+x$ direction, her coordinate is given by $x_g = \frac{1}{2} a_g t^2$. The sled starts at $x_0$ = 15 m and moves in the $-x$ direction. Its coordinate is given by $x_s = x_0 - \frac{1}{2} a_s t^2$. They meet when $x_g = x_s$, or

$$\frac{1}{2} a_g t^2 = x_0 - \frac{1}{2} a_s t^2.$$

This occurs at time

$$t = \sqrt{\frac{2x_0}{a_g + a_s}}.$$

By then, the girl has gone the distance

$$x_g = \frac{1}{2} a_g t^2 = \frac{x_0 a_g}{a_g + a_s} = \frac{(15\ \text{m})\left(0.13\ \text{m/s}^2\right)}{0.13\ \text{m/s}^2 + 0.62\ \text{m/s}^2} = 2.6\ \text{m}.$$