SOLUTION We have to resolve only one vector into components, the weight $\vec{\mathbf{F}}_G$, and its components are shown as dashed lines in Fig. 4–34c. To be general, we use θ rather than 30° for now. We use the definitions of sine ("side opposite") and cosine ("side adjacent") to obtain the components:

$$F_{Gx} = mg\sin\theta,$$
$$F_{Gy} = -mg\cos\theta.$$

where F_{Gy} is in the negative y direction.
(*a*) To calculate the skier's acceleration down the hill, a_x, we apply Newton's second law to the x direction:

$$\Sigma F_x = ma_x$$
$$mg\sin\theta - \mu_k F_N = ma_x$$

where the two forces are the x component of the gravity force ($+x$ direction) and the friction force ($-x$ direction). We want to find the value of a_x, but we don't yet know F_N in the last equation. Let's see if we can get F_N from the y component of Newton's second law:

$$\Sigma F_y = ma_y$$
$$F_N - mg\cos\theta = ma_y = 0$$

where we set $a_y = 0$ because there is no motion in the y direction (perpendicular to the slope). Thus we can solve for F_N:

$$F_N = mg\cos\theta$$

and we can substitute this into our equation above for ma_x:

$$mg\sin\theta - \mu_k(mg\cos\theta) = ma_x.$$

There is an m in each term which can be canceled out. Thus (setting $\theta = 30°$ and $\mu_k = 0.10$):

$$a_x = g\sin 30° - \mu_k g\cos 30°$$
$$= 0.50g - (0.10)(0.866)g = 0.41g.$$

The skier's acceleration is 0.41 times the acceleration of gravity, which in numbers is $a = (0.41)(9.8\,\text{m/s}^2) = 4.0\,\text{m/s}^2$. It is interesting that the mass canceled out here, and so we have the useful conclusion that *the acceleration doesn't depend on the mass*. That such a cancellation sometimes occurs, and thus may give a useful conclusion as well as saving calculation, is a big advantage of working with the algebraic equations and putting in the numbers only at the end.

PROBLEM SOLVING
It is often helpful to put in numbers only at the end

(*b*) The speed after 4.0 s is found, since the acceleration is constant, by using Eq. 2–11a:

$$v = v_0 + at$$
$$= 0 + (4.0\,\text{m/s}^2)(4.0\,\text{s}) = 16\,\text{m/s},$$

where we assumed a start from rest.

In problems involving a slope or "inclined plane," it is common to make an error in the direction of the normal force or in the direction of gravity. The normal force is *not* vertical in Example 4–21. It is perpendicular to the slope or plane. And gravity is *not* perpendicular to the slope or plane—gravity acts vertically downward toward the center of the Earth.

CAUTION
Directions of gravity and the normal force