The force of friction also depends on the composition and qualities of the surfaces in contact. For example, it is easier to push a desk across a tile floor than across a floor covered with carpet. Although the normal force on the desk is the same in both cases, the force of friction between the desk and the carpet is higher than the force of friction between the desk and the tile. The quantity that expresses the dependence of frictional forces on the particular surfaces in contact is called the **coefficient of friction.** The coefficient of friction between a waxed snowboard and the snow will affect the acceleration of the snowboarder shown in **Figure 15.** The coefficient of friction is represented by the symbol $\mu$, the lowercase Greek letter *mu*.

**coefficient of friction**

*the ratio of the magnitude of the force of friction between two objects in contact to the magnitude of the normal force with which the objects press against each other*

### The coefficient of friction is a ratio of forces

The coefficient of friction is defined as the ratio of the force of friction to the normal force between two surfaces. The *coefficient of kinetic friction* is the ratio of the force of kinetic friction to the normal force.

$$\mu_k = \frac{F_k}{F_n}$$

The *coefficient of static friction* is the ratio of the maximum value of the force of static friction to the normal force.

$$\mu_s = \frac{F_{s,max}}{F_n}$$

If the value of $\mu$ and the normal force on the object are known, then the magnitude of the force of friction can be calculated directly.

$$F_f = \mu F_n$$

**Table 2** shows some experimental values of $\mu_s$ and $\mu_k$ for different materials. Because kinetic friction is less than or equal to the maximum static friction, the coefficient of kinetic friction is always less than or equal to the coefficient of static friction.

**Figure 15**
Snowboarders wax their boards to minimize the coefficient of friction between the boards and the snow.

**Table 2 Coefficients of Friction (Approximate Values)**

| | $\mu_s$ | $\mu_k$ | | $\mu_s$ | $\mu_k$ |
|---|---|---|---|---|---|
| steel on steel | 0.74 | 0.57 | waxed wood on wet snow | 0.14 | 0.1 |
| aluminum on steel | 0.61 | 0.47 | waxed wood on dry snow | — | 0.04 |
| rubber on dry concrete | 1.0 | 0.8 | metal on metal (lubricated) | 0.15 | 0.06 |
| rubber on wet concrete | — | 0.5 | ice on ice | 0.1 | 0.03 |
| wood on wood | 0.4 | 0.2 | Teflon on Teflon | 0.04 | 0.04 |
| glass on glass | 0.9 | 0.4 | synovial joints in humans | 0.01 | 0.003 |