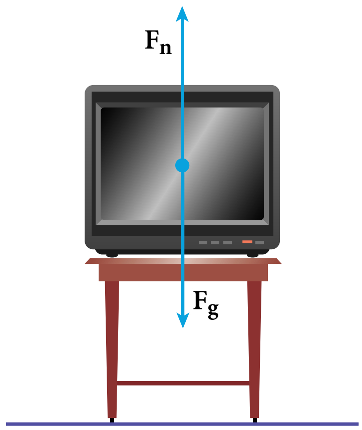

Figure 11
In this example, the normal force, $\mathbf{F_n}$, is equal and opposite to the force due to gravity, $\mathbf{F_g}$.

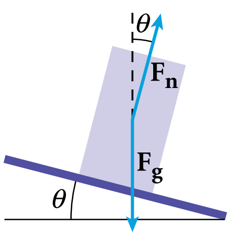

Figure 12
The normal force is not always opposite the force due to gravity, as shown by this example of a refrigerator on a loading ramp.

static friction

the force that resists the initiation of sliding motion between two surfaces that are in contact and at rest

The word *normal* is used because the direction of the contact force is perpendicular to the table surface and one meaning of the word *normal* is "perpendicular." **Figure 11** shows the forces acting on the television.

The normal force is always perpendicular to the contact surface but is not always opposite in direction to the force due to gravity. **Figure 12** shows a free-body diagram of a refrigerator on a loading ramp. The normal force is perpendicular to the ramp, not directly opposite the force due to gravity. In the absence of other forces, the normal force, $\mathbf{F_n}$, is equal and opposite to the component of $\mathbf{F_g}$ that is perpendicular to the contact surface. The magnitude of the normal force can be calculated as $F_n = mg \cos \theta$. The angle θ is the angle between the normal force and a vertical line and is also the angle between the contact surface and a horizontal line.

THE FORCE OF FRICTION

Consider a jug of juice at rest (in equilibrium) on a table, as in **Figure 13(a).** We know from Newton's first law that the net force acting on the jug is zero. Newton's second law tells us that any additional unbalanced force applied to the jug will cause the jug to accelerate and to remain in motion unless acted on by another force. But experience tells us that the jug will not move at all if we apply a very small horizontal force. Even when we apply a force large enough to move the jug, the jug will stop moving almost as soon as we remove this applied force.

Friction opposes the applied force

When the jug is at rest, the only forces acting on it are the force due to gravity and the normal force exerted by the table. These forces are equal and opposite, so the jug is in equilibrium. When you push the jug with a small horizontal force **F**, as shown in **Figure 13(b),** the table exerts an equal force in the opposite direction. As a result, the jug remains in equilibrium and therefore also remains at rest. The resistive force that keeps the jug from moving is called the force of **static friction,** abbreviated as $\mathbf{F_s}$.

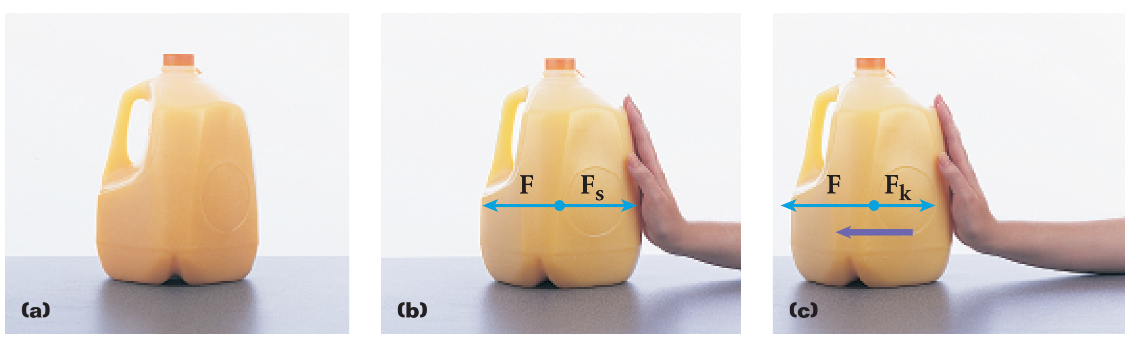

Figure 13
(a) Because this jug of juice is in equilibrium, any unbalanced horizontal force applied to it will cause the jug to accelerate.
(b) When a small force is applied, the jug remains in equilibrium because the static-friction force is equal but opposite to the applied force.
(c) The jug begins to accelerate as soon as the applied force exceeds the opposing static-friction force.