Quick Lab

Elevator Acceleration

MATERIALS LIST

- elevator
- bathroom scale
- watch or stopwatch

In this activity, you will stand on a bathroom scale while riding an elevator up to the top floor and then back. Stand on the scale in a first-floor elevator, and record your weight. As the elevator moves up, record the scale reading for every two-second interval. Repeat the process as the elevator moves down.

Now, find the net force for each time interval, and then use Newton's second law to calculate the elevator's acceleration for each interval. How does the acceleration change? How does the elevator's maximum acceleration compare with free-fall acceleration?

WEIGHT AND WEIGHTLESSNESS

In the chapter about forces, you learned that weight is the magnitude of the force due to gravity. When you step on a bathroom scale, it does not actually measure your weight. The scale measures the downward force exerted on it. When your weight is the only downward force acting on the scale, the scale reading equals your weight. If a friend pushes down on you while you are standing on the scale, the scale reading will go up. However, your weight has not changed; the scale reading equals your weight plus the extra applied force. Because of Newton's third law, the downward force you exert on the scale equals the upward force exerted on you by the scale (the normal force). Thus, the scale reading is equal to the normal force acting on you.

For example, imagine you are standing in an elevator, as illustrated in **Figure 13.** When the elevator is at rest, as in **Figure 13(a),** the magnitude of the normal force is equal to your weight. A scale in the elevator would record your weight. When the elevator begins accelerating downward, as in **Figure 13(b),** the normal force will be smaller. The scale would now record an amount that is less than your weight. If the elevator's acceleration were equal to free-fall acceleration, as shown in **Figure 13(c),** you would be falling at the same rate as the elevator and would not feel the force of the floor at all. In this case, the scale would read zero. You still have the same weight, but you and the elevator are both falling with free-fall acceleration. In other words, no normal force is acting on you. This situation is called *apparent weightlessness.*

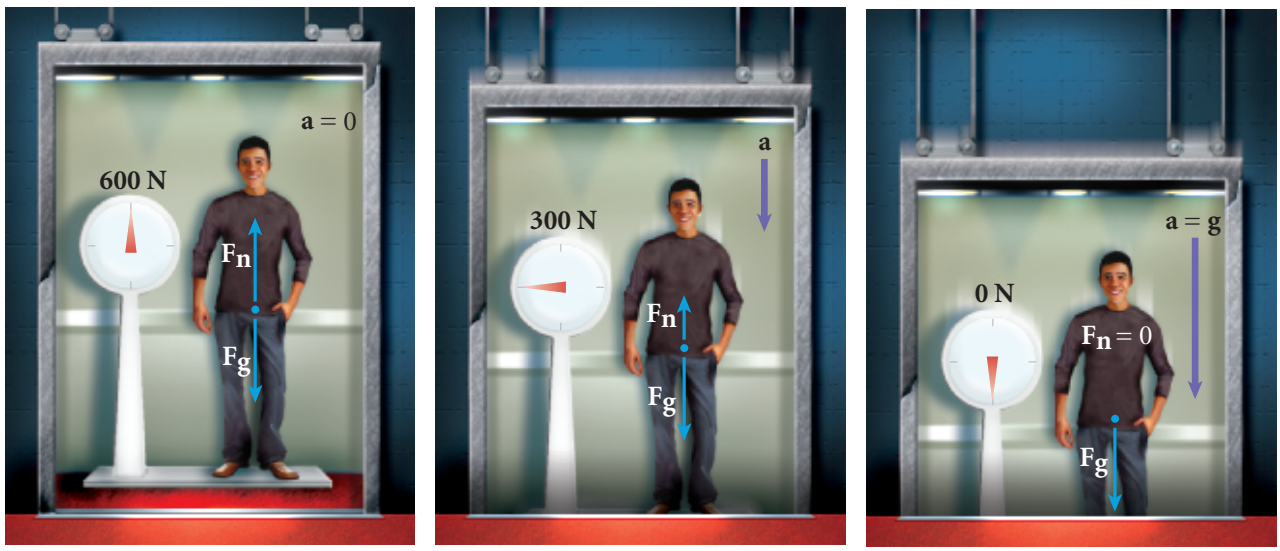

Figure 13
When this elevator accelerates, the normal force acting on the person changes. If the elevator were in free fall, the normal force would drop to zero and the person would experience a sensation of apparent weightlessness.