SECTION 3

Newton's Second and Third Laws

SECTION OBJECTIVES

- **Describe an object's acceleration in terms of its mass and the net force acting on it.**
- **Predict the direction and magnitude of the acceleration caused by a known net force.**
- **Identify action-reaction pairs.**

NEWTON'S SECOND LAW

From Newton's first law, we know that an object with no net force acting on it is in a state of equilibrium. We also know that an object experiencing a net force undergoes a change in its velocity. But exactly how much does a known force affect the motion of an object?

Force is proportional to mass and acceleration

Imagine pushing a stalled car through a level intersection, as shown in **Figure 7.** Because a net force causes an object to accelerate, the speed of the car will increase. When you push the car by yourself, however, the acceleration will be so small that it will take a long time for you to notice an increase in the car's speed. If you get several friends to help you, the net force on the car is much greater, and the car will soon be moving so fast that you will have to run to keep up with it. This change happens because the acceleration of an object is directly proportional to the net force acting on the object. (Note that this is an idealized example that disregards any friction forces that would hinder the motion. In reality, the car accelerates when the push is greater than the frictional force. However, when the force exerted by the pushers equals the frictional force, the net force becomes zero, and the car moves at a constant velocity.)

Experience reveals that the mass of an object also affects the object's acceleration. A lightweight car accelerates more than a heavy truck if the same force is applied to both. Thus, it requires less force to accelerate a low-mass object than it does to accelerate a high-mass object at the same rate.

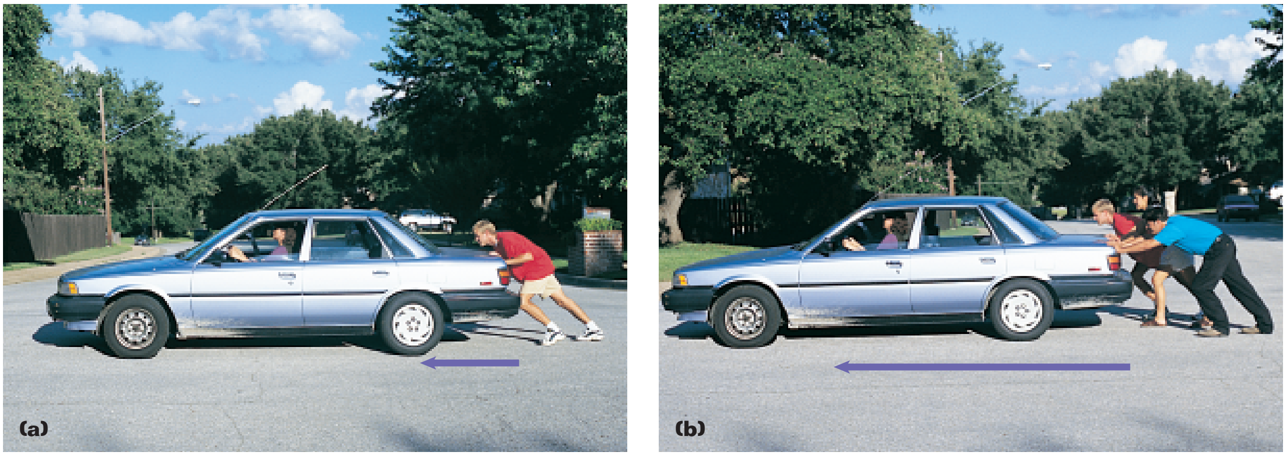

Figure 7
(a) A small force on an object causes a small acceleration, but **(b)** a larger force causes a larger acceleration.