Newton's second law relates force, mass, and acceleration

The relationships between mass, force, and acceleration are quantified in **Newton's second law.**

NEWTON'S SECOND LAW

The acceleration of an object is directly proportional to the net force acting on the object and inversely proportional to the object's mass.

According to Newton's second law, if equal forces are applied to two objects of different masses, the object with greater mass will experience a smaller acceleration, and the object with less mass will experience a greater acceleration.

In equation form, we can state Newton's law as follows:

NEWTON'S SECOND LAW

$$\Sigma \mathbf{F} = m\mathbf{a}$$

$$\text{net force} = \text{mass} \times \text{acceleration}$$

In this equation, **a** is the acceleration of the object and m is the object's mass. Note that Σ is the Greek capital letter *sigma,* which represents the sum of the quantities that come after it. In this case, $\Sigma\mathbf{F}$ represents the *vector sum of all external forces acting on the object,* or the net force.

SAMPLE PROBLEM C

Newton's Second Law

PROBLEM

Roberto and Laura are studying across from each other at a wide table. Laura slides a 2.2 kg book toward Roberto. If the net force acting on the book is 1.6 N to the right, what is the book's acceleration?

SOLUTION

Given: $m = 2.2$ kg

$\mathbf{F}_{\text{net}} = \Sigma\mathbf{F} = 1.6$ N to the right

Unknown: $\mathbf{a} = ?$

Use Newton's second law, and solve for **a.**

$$\Sigma\mathbf{F} = m\mathbf{a}, \text{ so } \mathbf{a} = \frac{\Sigma\mathbf{F}}{m}$$

$$a = \frac{1.6 \text{ N}}{2.2 \text{ kg}} = 0.73 \text{ m/s}^2$$

$$\mathbf{a} = 0.73 \text{ m/s}^2 \text{ to the right}$$

TIP

If more than one force is acting on an object, you must find the net force as shown in Sample Problem B before applying Newton's second law. The acceleration will be in the direction of the net force.