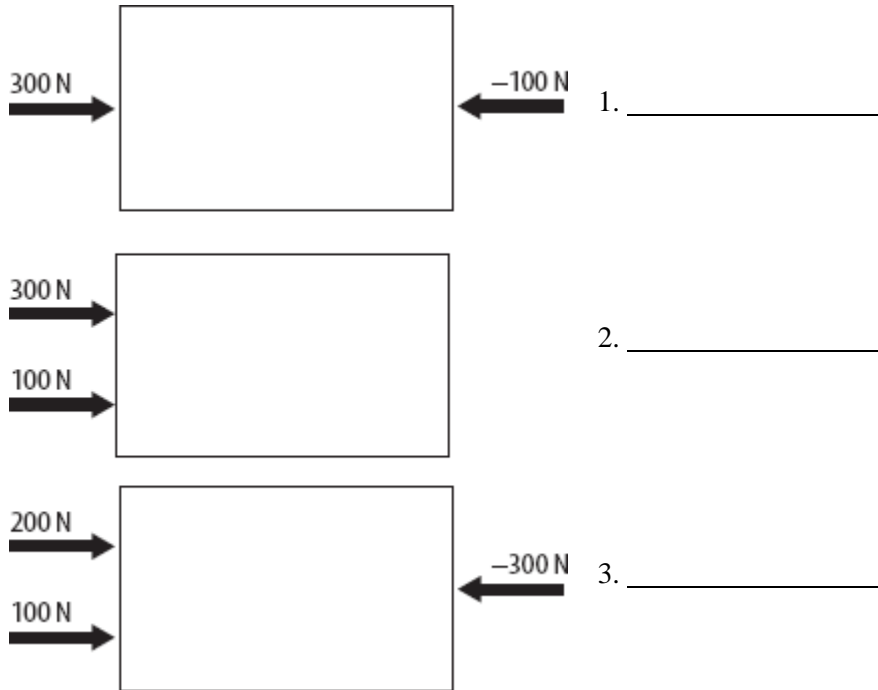


## Newton's First Law

**Key Concept** How is motion related to balanced and unbalanced forces?

**Directions:** The diagrams below represent sliding forces applied to a large box. Write the net force applied to each box on the line next to each diagram.



**Directions:** On each line, write the term that correctly completes the sentence.

4. Because forces have directions, you must specify a(n) \_\_\_\_\_ when you combine forces.
5. A force exerted in that direction is \_\_\_\_\_, and a force exerted in the opposite direction is \_\_\_\_\_.
6. The combination of forces acting on an object is the \_\_\_\_\_.

## Newton's Second Law Equation

Newton's second law of motion states that the acceleration of an object equals the net force on the object divided by the object's mass. This can be shown by the equation below, where  $a$  = acceleration (in  $\text{m/s}^2$ ),  $F$  = net force (N), and  $m$  = mass (in kg).

$$a = \frac{F}{m}$$

You can rearrange the equation to solve for force or mass.

$$F = m \times a \qquad m = \frac{F}{a}$$

If a **4.5-kg** bowling ball is rolled down the bowling lane with a force of **15 N**, what is the acceleration of the ball?

Step 1 Identify the variable you will solve for and choose the appropriate equation.  
You are solving for  $a$ , the acceleration.

$$a = \frac{F}{m}$$

Step 2 Substitute the known values to solve the equation.

$$a = \frac{15 \text{ N}}{4.5 \text{ kg}}$$

$$a = 3.3 \text{ m/s}^2$$

### Practice

1. If a 6-kg bowling ball is rolled down the bowling lane with a force of 12 N, what is the acceleration of the ball?
2. If a 16-N net force makes an object accelerate at  $8 \text{ m/s}^2$ , what is the mass of the object?
3. A 25-N net force is applied to a rolling cart and produces an acceleration of  $5 \text{ m/s}^2$ . What is the cart's mass?
4. A 0.5-kg ball accelerated at  $50 \text{ m/s}^2$ . What force was applied?

Key Concept Builder



LESSON 4

## Newton's Third Law

**Key Concept** What is Newton's third law of motion?

**Directions:** Each of the following object pairs exerts forces on each other. Write A on the line next to objects that exert the action force and write R next to objects that exert the reaction force.

1. swimmer's hands \_\_\_\_\_ /water \_\_\_\_\_
2. a starting block \_\_\_\_\_ /a runner's foot \_\_\_\_\_
3. a baseball bat \_\_\_\_\_ /a baseball \_\_\_\_\_
4. water under a paddle \_\_\_\_\_ /a paddle pushing a boat \_\_\_\_\_
5. a table \_\_\_\_\_ /a cat jumping off a table \_\_\_\_\_
6. an arrow \_\_\_\_\_ /a target \_\_\_\_\_
7. an airplane wing pushing down on air \_\_\_\_\_ /air pushing up on a wing \_\_\_\_\_
8. a girl sitting in a chair \_\_\_\_\_ /a chair supporting a girl \_\_\_\_\_
9. a windmill \_\_\_\_\_ /wind \_\_\_\_\_
10. a pencil \_\_\_\_\_ /a piece of paper \_\_\_\_\_