

# 11.2 Speed and Velocity

## Reading Focus

### Key Concepts

- ➔ How are instantaneous speed and average speed different?
- ➔ How can you find the speed from a distance-time graph?
- ➔ How are speed and velocity different?
- ➔ How do velocities add?

### Vocabulary

- ◆ speed
- ◆ average speed
- ◆ instantaneous speed
- ◆ velocity

### Reading Strategy

**Monitoring Your Understanding** After you have finished reading this section, copy the table below. Identify several things you have learned that are relevant to your life. Explain why they are relevant to you.

What Is Relevant	Why It Is Relevant
a. ?	b. ?
c. ?	d. ?
e. ?	f. ?

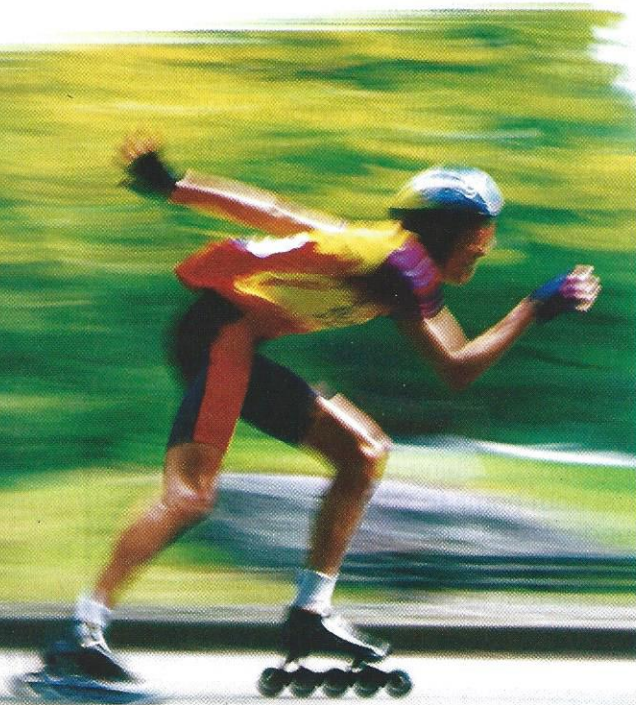
**Figure 5** The speed of an in-line skater is usually described in meters per second. The speed of a car is usually described in kilometers per hour.

Look out a window for a few minutes, and you will see things in motion. Some things are moving slowly. Perhaps you see a leaf floating through the air. Other things, such as a car or a bird, are moving fast. The growth rate of trees and grass is so slow that their motion cannot be detected with the unaided eye. The differences among these types of motion can be described in terms of speed.

## Speed

To describe the speed of a car, you might say it is moving at 45 kilometers per hour. **Speed** is the ratio of the distance an object moves to the amount of time the object moves. The SI unit of speed is meters per second (m/s). However, just as with distances, you need to choose units that make the most sense for the motion you are describing. The in-line skater in Figure 5 may travel 2 meters in one second. The speed would be expressed as 2 m/s. A car might travel 80 kilometers in one hour. Its speed would be expressed as 80 km/h.

Two ways to express the speed of an object are average speed and instantaneous speed. ➔ **Average speed is computed for the entire duration of a trip, and instantaneous speed is measured at a particular instant.** In different situations, either one or both of these measurements may be a useful way to describe speed.



**Average Speed** Describing the speed of a hiker isn't as easy as describing constant speed along a straight line. A hiker may travel slowly along rocky areas but then travel quickly when going downhill. Sometimes it is useful to know how fast something moves for an entire trip. **Average speed**,  $\bar{v}$ , is the total distance traveled,  $d$ , divided by the time,  $t$ , it takes to travel that distance. This can be written as an equation:

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}, \text{ or } \bar{v} = \frac{d}{t}$$

During the time an object is moving, its speed may change, but this equation tells you the average speed over the entire trip.

## Math Skills

### Calculating Average Speed

While traveling on vacation, you measure the times and distances traveled. You travel 35 kilometers in 0.4 hour, followed by 53 kilometers in 0.6 hour. What is your average speed?

#### 1 Read and Understand

*What information are you given?*

$$\text{Total Distance } (d) = 35 \text{ km} + 53 \text{ km} = 88 \text{ km}$$

$$\text{Total Time } (t) = 0.4 \text{ h} + 0.6 \text{ h} = 1.0 \text{ h}$$

#### 2 Plan and Solve

*What unknown are you trying to calculate?*

$$\text{Average Speed } (\bar{v}) = ?$$

*What formula contains the given quantities and the unknown?*

$$\bar{v} = \frac{d}{t}$$

*Replace each variable with its known value.*

$$\bar{v} = \frac{88 \text{ km}}{1 \text{ h}} = 88 \text{ km/h}$$

#### 3 Look Back and Check

*Is your answer reasonable?*

Yes, 88 km/h is a typical highway speed.

## Math Practice

1. A person jogs 4.0 kilometers in 32 minutes, then 2.0 kilometers in 22 minutes, and finally 1.0 kilometer in 16 minutes. What is the jogger's average speed in kilometers per minute?
2. A train travels 190 kilometers in 3.0 hours, and then 120 kilometers in 2.0 hours. What is its average speed?