Velocity is not the same as speed

In everyday language, the terms *speed* and *velocity* are used interchangeably. In physics, however, there is an important distinction between these two terms. As we have seen, velocity describes motion with both a direction and a numerical value (a magnitude) indicating how fast something moves. However, speed has no direction, only magnitude. An object's average speed is equal to the distance traveled divided by the time interval for the motion.

$$\text{average speed} = \frac{\text{distance traveled}}{\text{time of travel}}$$

Velocity can be interpreted graphically

The velocity of an object can be determined if the object's position is known at specific times along its path. One way to determine this is to make a graph of the motion. **Figure 5** represents such a graph. Notice that time is plotted on the horizontal axis and position is plotted on the vertical axis.

The object moves 4.0 m in the time interval between $t = 0$ s and $t = 4.0$ s. Likewise, the object moves an additional 4.0 m in the time interval between $t = 4.0$ s and $t = 8.0$ s. From these data, we see that the average velocity for each of these time intervals is +1.0 m/s (because $v_{avg} = \Delta x/\Delta t = 4.0$ m/4.0 s). Because the average velocity does not change, the object is moving with a constant velocity of +1.0 m/s, and its motion is represented by a straight line on the position-time graph.

For any position-time graph, we can also determine the average velocity by drawing a straight line between any two points on the graph. The slope of this line indicates the average velocity between the positions and times represented by these points. To better understand this concept, compare the equation for the slope of the line with the equation for the average velocity.
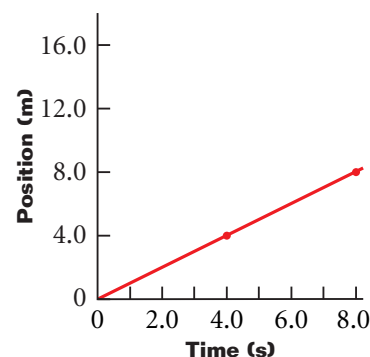
Figure 5
The motion of an object moving with constant velocity will provide a straight-line graph of position versus time. The slope of this graph indicates the velocity.

Slope of a Line

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{\text{change in vertical coordinates}}{\text{change in horizontal coordinates}}$$

Average Velocity

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

Why it Matters

Conceptual Challenge

1. Book on a Table A book is moved once around the edge of a tabletop with dimensions 1.75 m × 2.25 m. If the book ends up at its initial position, what is its displacement? If it completes its motion in 23 s, what is its average velocity? What is its average speed?

2. Travel Car A travels from New York to Miami at a speed of 25 m/s. Car B travels from New York to Chicago, also at a speed of 25 m/s. Are the velocities of the cars equal? Explain.