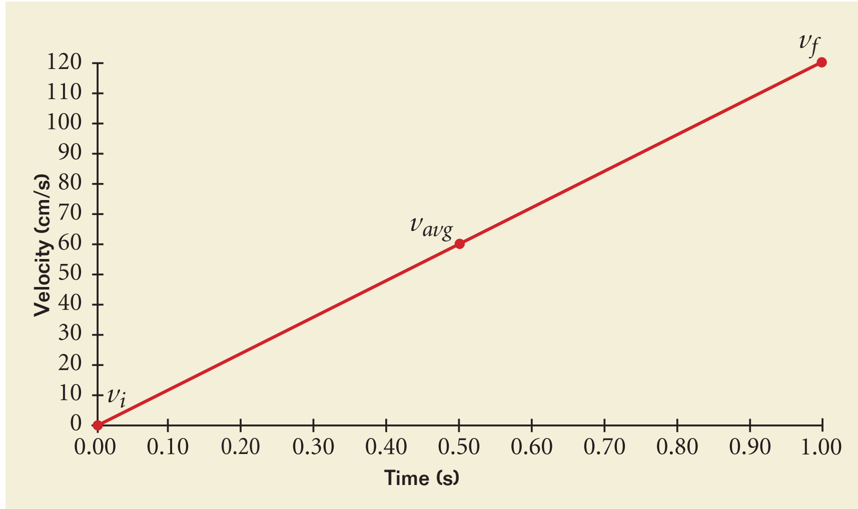

Figure 12
If a ball moved for the same time with a constant velocity equal to v_{avg}, it would have the same displacement as the ball in **Figure 11** moving with constant acceleration.

Did you know?

Decreases in speed are sometimes called *decelerations*. Despite the sound of the name, decelerations are really a special case of acceleration in which the magnitude of the velocity—and thus the speed—decreases with time.

Displacement depends on acceleration, initial velocity, and time

Figure 12 is a graph of the ball's velocity plotted against time. The initial, final, and average velocities are marked on the graph. We know that the average velocity is equal to displacement divided by the time interval.

$$v_{avg} = \frac{\Delta x}{\Delta t}$$

For an object moving with constant acceleration, the average velocity is equal to the average of the initial velocity and the final velocity.

$$v_{avg} = \frac{v_i + v_f}{2} \qquad \text{average velocity} = \frac{\text{initial velocity} + \text{final velocity}}{2}$$

To find an expression for the displacement in terms of the initial and final velocity, we can set the expressions for average velocity equal to each other.

$$\frac{\Delta x}{\Delta t} = v_{avg} = \frac{v_i + v_f}{2}$$

$$\frac{\text{displacement}}{\text{time interval}} = \frac{\text{initial velocity} + \text{final velocity}}{2}$$

Multiplying both sides of the equation by Δt gives us an expression for the displacement as a function of time. This equation can be used to find the displacement of any object moving with constant acceleration.

DISPLACEMENT WITH CONSTANT ACCELERATION

$$\Delta x = \tfrac{1}{2}(v_i + v_f)\Delta t$$

$$\textbf{displacement} = \tfrac{1}{2}(\textbf{initial velocity} + \textbf{final velocity})(\textbf{time interval})$$

ADVANCED TOPICS

See "Angular Kinematics" in **Appendix J: Advanced Topics** to learn how displacement, velocity, and acceleration can be used to describe circular motion.