Final velocity depends on initial velocity, acceleration, and time

What if the final velocity of the ball is not known but we still want to calculate the displacement? If we know the initial velocity, the acceleration, and the elapsed time, we can find the final velocity. We can then use this value for the final velocity to find the total displacement of the ball.

By rearranging the equation for acceleration, we can find a value for the final velocity.

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$$

$$a\Delta t = v_f - v_i$$

By adding the initial velocity to both sides of the equation, we get an equation for the final velocity of the ball.

$$a\Delta t + v_i = v_f$$

VELOCITY WITH CONSTANT ACCELERATION

$$v_f = v_i + a\Delta t$$

final velocity = initial velocity + (acceleration × time interval)

You can use this equation to find the final velocity of an object after it has accelerated at a constant rate for any time interval.

If you want to know the displacement of an object moving with constant acceleration over some certain time interval, you can obtain another useful expression for displacement by substituting the expression for v_f into the expression for Δx.

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

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

$$\Delta x = \tfrac{1}{2}[2v_i\Delta t + a(\Delta t)^2]$$

DISPLACEMENT WITH CONSTANT ACCELERATION

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

displacement = (initial velocity × time interval) + $\frac{1}{2}$ acceleration × (time interval)^2

This equation is useful not only for finding the displacement of an object moving with constant acceleration but also for finding the displacement required for an object to reach a certain speed or to come to a stop. For the latter situation, you need to use both this equation and the equation given above.

ADVANCED TOPICS

See "Special Relativity and Time Dilation" in **Appendix J: Advanced Topics** to learn about how time intervals are interpreted in Einstein's special theory of relativity.