Motion with Constant Acceleration

- When velocity changes by the same amount during each time interval, **acceleration is constant.**
- The relationships between **displacement, time, velocity,** and **constant acceleration** are expressed by the equations shown on the next slide. These equations apply to any object moving with constant acceleration.
- These equations use the following symbols:

Δx = displacement
v_i = initial velocity
v_f = final velocity
Δt = time interval

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Equations for Constantly Accelerated Straight-Line Motion

Form to use when accelerating object has an initial velocity	Form to use when accelerating object starts from rest
$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$	$\Delta x = \frac{1}{2}v_f\Delta t$
$v_f = v_i + a\Delta t$	$v_f = a\Delta t$
$\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$	$\Delta x = \frac{1}{2}a(\Delta t)^2$
$v_f^2 = v_i^2 + 2a\Delta x$	$v_f^2 = 2a\Delta x$

Sample Problem

Final Velocity After Any Displacement

A person pushing a stroller starts from rest, uniformly accelerating at a rate of 0.500 m/s^2. What is the velocity of the stroller after it has traveled 4.75 m?

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Sample Problem, *continued*

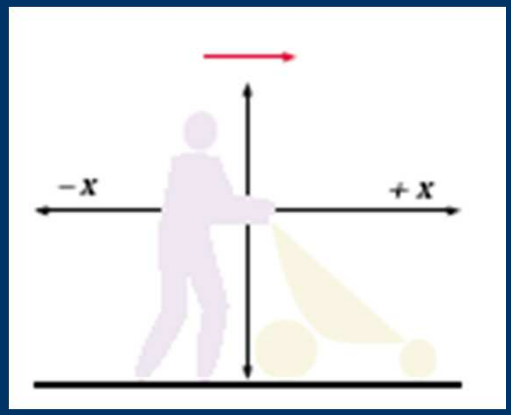
1. Define

Given:

$v_i = 0$ m/s

$a = 0.500$ m/s^2

$\Delta x = 4.75$ m



Unknown:

$v_f = ?$

Diagram: Choose a coordinate system. The most convenient one has an origin at the initial location of the stroller, as shown above. The positive direction is to the right.

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Sample Problem, *continued*

2. Plan

Choose an equation or situation: Because the initial velocity, acceleration, and displacement are known, the final velocity can be found using the following equation:

$$v_f^2 = v_i^2 + 2a\Delta x$$

Rearrange the equation to isolate the unknown: Take the square root of both sides to isolate v_f .

$$v_f = \pm\sqrt{v_i^2 + 2a\Delta x}$$

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Sample Problem, *continued*

3. Calculate

Substitute the values into the equation and solve:

$$v_f = \pm\sqrt{(0\ \text{m/s})^2 + 2(0.500\ \text{m/s}^2)(4.75\ \text{m})}$$

$$\boxed{v_f = +2.18\ \text{m/s}}$$

Tip: *Think about the physical situation to determine whether to keep the positive or negative answer from the square root. In this case, the stroller starts from rest and ends with a speed of 2.18 m/s. An object that is speeding up and has a positive acceleration must have a positive velocity. So, the final velocity must be positive.*

4. Evaluate

The stroller's velocity after accelerating for 4.75 m is 2.18 m/s to the right.

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