Physics 200 (Stapleton)
1-D Kinematics Notes, Part 1

Name: Key

Kinematics: The study of motion without considering its causes.

Scalar: A quantity with magnitude but no direction.

Vector: A quantity with magnitude and direction. Numerically, may be positive or negative, depending on the chosen reference frame. Usually, signs follow the same conventions as an x/y grid… upward = positive, downward = negative, rightward = positive, leftward = negative.

Δ = Delta = "change in". If x changes from 3m to 1m, then Δx = -2m.

Preview of Kinematics Formulas to Come

$$x = x_0 + \overline{v}\,t$$

$$\overline{v} = \frac{v_0 + v}{2}$$

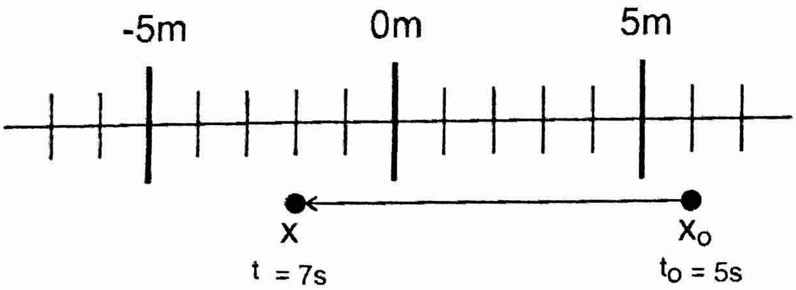
$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$v^2 = v_0^2 + 2a\left(x - x_0\right)$$

	Symbol	**Meaning** (what it's *supposed to* mean)	**Vector or Scalar?**	**Common Units**	**How to estimate or convert**
Position	x (or y, depending on axis of motion)	Current distance (in a positive or negative direction) from some chosen point of origin.	S	Meters (m)	1 long step 0.305m ≈ 1foot
Displacement (often called "distance.")	Δx (or Δy) *Sometimes = d*	Final position minus original position(e.g. $x-x_0$); "Change in position"	V	Meters (m)	1 long step 0.305m ≈ 1foot
Distance	d	How far something has traveled from its original position, disregarding direction. Distance is not negative.	S	Meters (m)	1 long step 0.305m ≈ 1foot
Distance traveled	d	Sum of all of the distances traveled on a trip. Distance traveled is what is recorded by a car's odometer.	S	Meters (m)	1 long step 0.305m ≈ 1foot
Time	t	?	S	Seconds (s)	1s = "one mississippi"
Speed	v *(even though v is technically velocity)*	How fast something is moving. A ratio of distance traveled to travel time.	S	Meters per second (m/s)	1m/s ≈ 2.234mph ≈ 1 long step per second
Velocity	v	Speed and direction. Speed that may be positive or negative.	V	Meters per second (m/s)	1m/s ≈ 2.234mph 4.5m/s = 6min/mile pace

Practice: At t=5s, an object leaves position x_o and travels to position x .



Position: x_o = $6m$ x = $-2m$

Displacement: $x - x_o = -2m - 6m = -8m = \Delta x$

Final Distance From Origin: 2m

Distance Traveled: 8m

Average Velocity: $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{-8m}{(7s - 5s)} = \frac{-8m}{2s} = -4m/s$

Average Speed: $\overline{speed} = |\bar{v}| = |-4m/s| = 4m/s$

***Average* Velocity** (symbol =): when we measure velocity, *average velocity* is what we will actually measure. This is the average speed of an object as it travels through a given distance. The object may speed up or slow down over that distance, but the average velocity that we calculate will not show this.

Instantaneous Velocity: the velocity of an object at a single point in time

"Initial velocity" symbol = V_o

Final velocity symbol = V

If I have a velocity of 3 m/s, what does that mean?

I travel a distance of 3m (in a positive direction) each second.

Explain how to walk with a velocity of 1m/s.

Take one long step every second.

Average Velocity Formula (Hint: the units provide the formula) $\frac{m}{s}$ ← distance / ← time

$\bar{v} = \frac{\Delta x}{\Delta t}$ ← displacement / ← elapsed time

Two Ways to Graph The Same Event

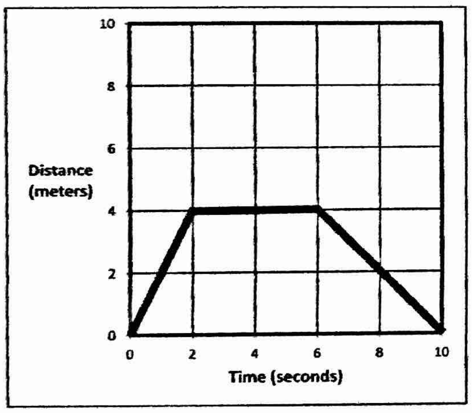
Position vs. time graph (below, left) [also called "distance vs. time"]:

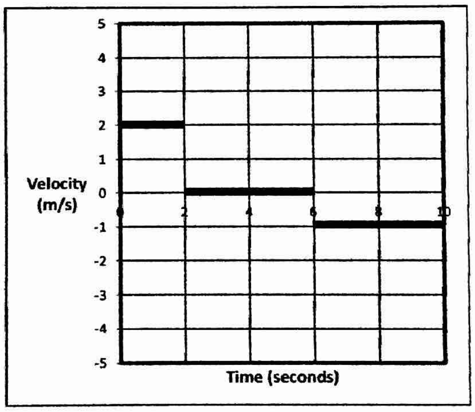
1. For the first 2 seconds, Chuck walked steadily away from a motion sensor. During that time, he traveled 4m "forward."
2. For the next 4 seconds (from t=2 to t=6), Chuck stood still at the 4m distance mark.
3. During the last 4 seconds (t=6 through t=10), Chuck walked steadily back toward the sensor. During those two seconds, Chuck traveled 2m "backward."

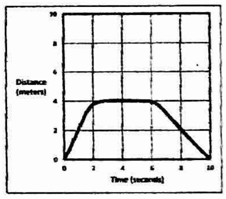
Velocity vs. time graph:

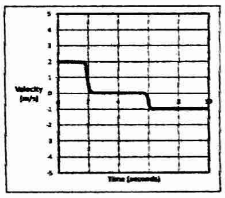
1. During the first segment, Chuck traveled 4m forward (+4m) over a time of 2s. His average velocity for that interval is therefore 4m/2s = 2m/s. The velocity vs. time graph shows a constant velocity of 2m/s for the first two seconds.
2. During the second segment of data (2s to 6s), Chuck stood still (0m distance) over a time of 4s. His average velocity for that interval was therefore 0m/4s = 0m/s. The velocity vs. time graph shows a constant velocity of 0m/s for the second segment of data.
3. During the 3rd segment (6s to 10s), Chuck moves 4m backward (-4m). His average velocity for that interval is therefore -4m/4s = -1m/s. The velocity vs. time graph shows a constant velocity of -1m/s for the second segment of data (6s through 10s).

The small graphs, below, are actually more realistic than the large graphs. Why?









Velocity Practice: The graph on the right shows the movement of an object in front of a motion sensor. Determine the velocity of the moving object for lettered each segment, and use your calculations to fill out a velocity vs. time graph for the object (bottom of page).

1. Fill in the correct information for segment **A**, in the graph on the right.

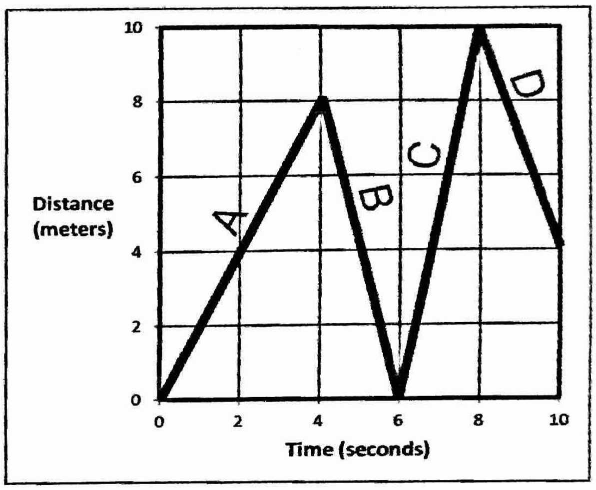
Displacement = 8m

Δt = 4s

$\bar{v}$ $v_{average}$ = 2m/s ($\frac{8m}{4s}$)

Distance traveled = 8m

Position at end of segment = 8m



2. Fill in the correct information for segment **B.**

Displacement = −8m

Δt = 2s

$v_{average}$ = −4m/s ($\frac{-8m}{2s}$)

Distance traveled = 8m

Position at end of segment = 0

3. Fill in the correct information for the entire trip (segments **A-D**).

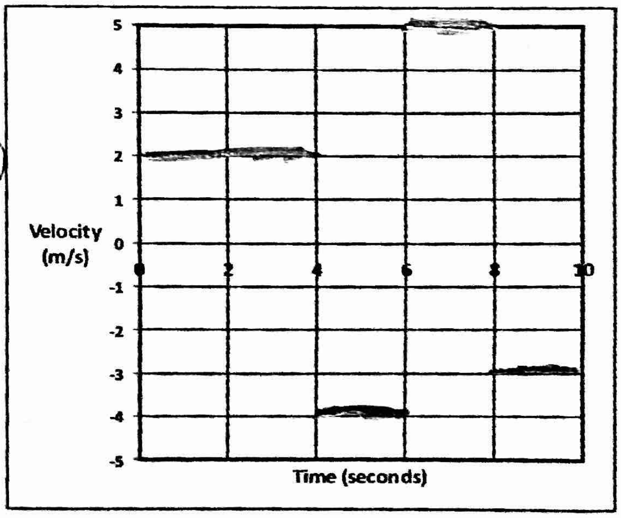
Displacement = 4m

Δt = 10s

$v_{average}$ = 0.4m/s ($\frac{4m}{10s}$)

Distance traveled = 32m (8+8+10+6)

Position at end of segment = 4m



4. Use the distance vs. time graph above to fill in the velocity vs. time graph on the right.

5. Fill in the correct information for segment **A**, in the graph on the right.

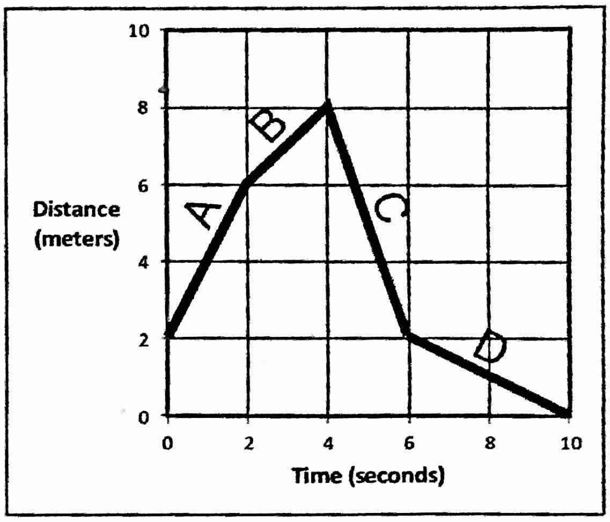
Displacement = 4m (6m − 2m)

Δt = 2s

V**average** = 2m/s ($\frac{4m}{2s}$)

Distance traveled = 4m

Position at end of segment = 6m



6. Fill in the correct information for segment **D**.

Displacement = 2m

Δt = 2s

V**average** = 1m/s ($\frac{2m}{2s}$)

Distance traveled = 2m

Position at end of segment = 8m

7. Fill in the correct information for the entire trip (segments **A-D**).

Displacement = −2m (0-2)

Δt = 10s

V**average** = −0.2m/s ($\frac{-2m}{10s}$)

Distance traveled = 14m (4+2+6+2)

Position at end of segment = 0m

8. Use the distance vs. time graph above to fill in the velocity vs. time graph on the right.