Physics 200 (Stapleton) Name: ___________________________________

1-D Kinematics Notes, Part 1

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

Preview of Kinematics Formulas to Come

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

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

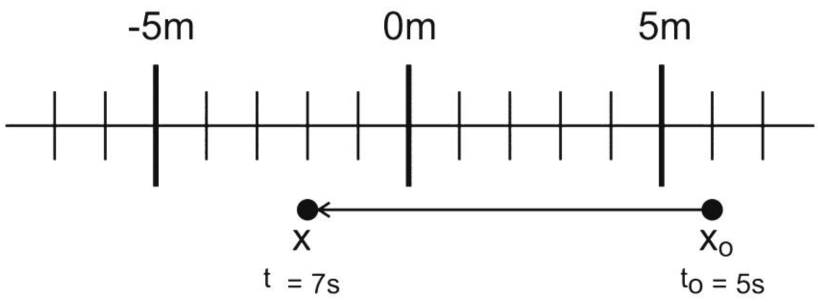
$$v = v_0 + at$$

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

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

	Symbol	**Meaning** <u>(what it's *supposed to* mean)</u>	**Vector or Scalar?**	**Common Units**	**How to estimate or convert**
Position	x (or y, depending on axis of motion)	An indicator of distance and direction from some chosen point of origin.		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"		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.		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 -- generally.		Meters (m)	1 long step 0.305m ≈ 1foot
Time	t	?		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 elapsed.		Meters per second (m/s)	1m/s ≈ 2.24mph ≈ 1 long step per second
Velocity	**v**	Speed in a particular direction. A ratio of displacement to travel time elapsed.		Meters per second (m/s)	1m/s ≈ 2.24 mph 4.5m/s = 6min/mile pace

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



Position: x_o = ___ x = ___

Displacement:

Final Distance From Origin:

Distance Traveled:

Average Velocity:

Average Speed:

***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 =

Final velocity symbol =

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

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

<u>**Average Velocity Formula**</u> (Hint: the units provide the formula)

<u>Two Ways to Graph The Same Event</u>

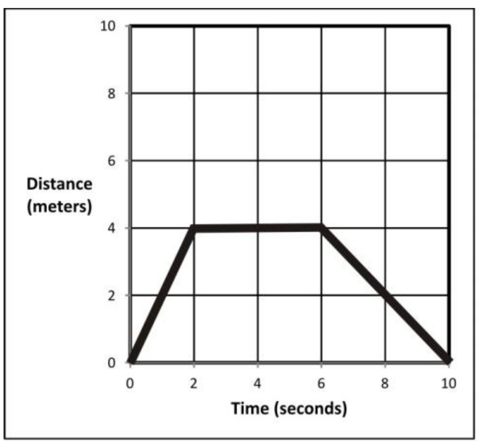
Position vs. time graph (below, left) [also called "distance vs. time"]:

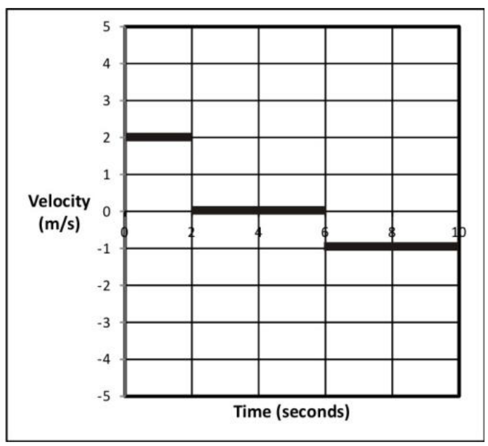
1. For the first 2 seconds, Chuck walked steadily away from a motion sensor. During that time, he traveled 4m "forward."
2. For the next 4 seconds (from t=2 to t=6), Chuck stood still at the 4m distance mark.
3. During the last 4 seconds (t=6 through t=10), Chuck walked steadily back toward the sensor.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

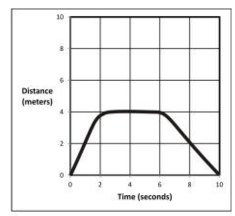
Velocity vs. time graph:

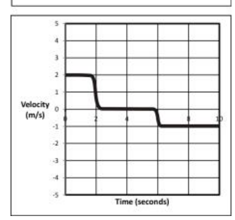
1. During the first segment, Chuck traveled 4m forward (+4m) over a time of 2s. His average velocity for that interval is therefore 4m/2s = 2m/s. The velocity vs. time graph shows a constant velocity of 2m/s for the first two seconds.
2. During the second segment of data (2s to 6s), Chuck stood still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



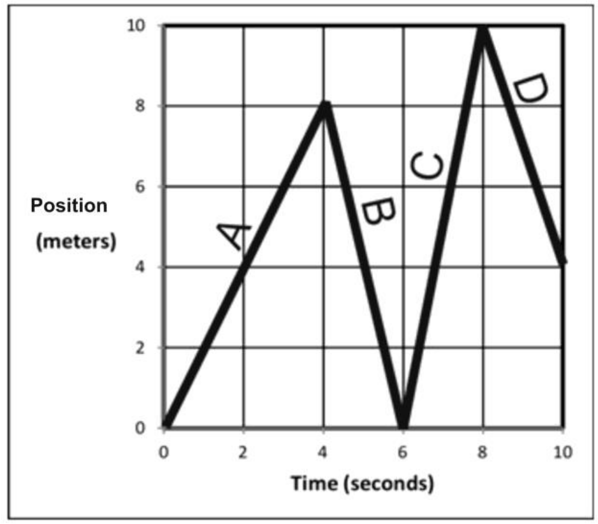






Velocity Practice: The graph on the right shows the movement of an object in front of a motion sensor. Determine the velocity of the moving object for lettered each segment, and use your calculations to fill out a velocity vs. time graph for the object (bottom of page).

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



Displacement = _________

Δt = _________

$v_{average}$ = __________

Distance traveled = ___________

Position at end of segment = ____________

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

Displacement = _________

Δt = _________

$v_{average}$ = __________

Distance traveled = ___________

Position at end of segment = ____________

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

Displacement = _________

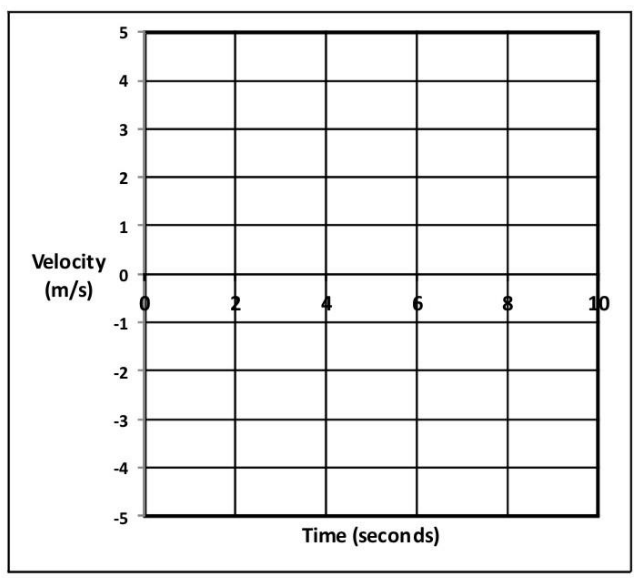
Δt = _________

$v_{average}$ = __________

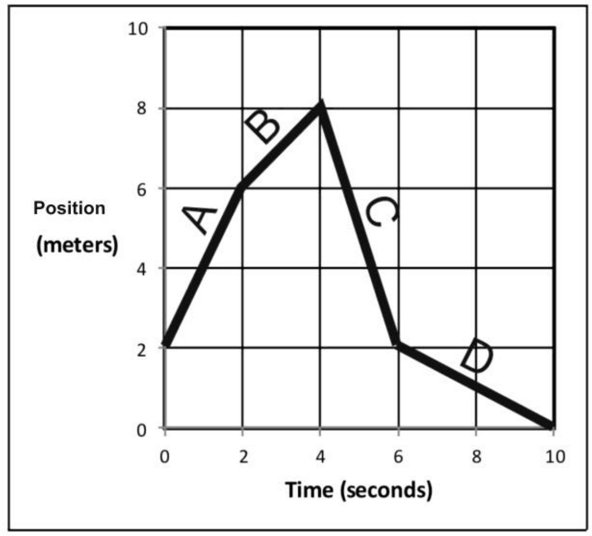
Distance traveled = ___________

Position at end of segment = ____________

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 = _________

Δt = _________

$\mathbf{v}_{\mathbf{average}}$ = __________

Distance traveled = ___________

Position at end of segment = ____________

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

Displacement = _________

Δt = _________

$\mathbf{v}_{\mathbf{average}}$ = __________

Distance traveled = ___________

Position at end of segment = ____________

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

Displacement = _________

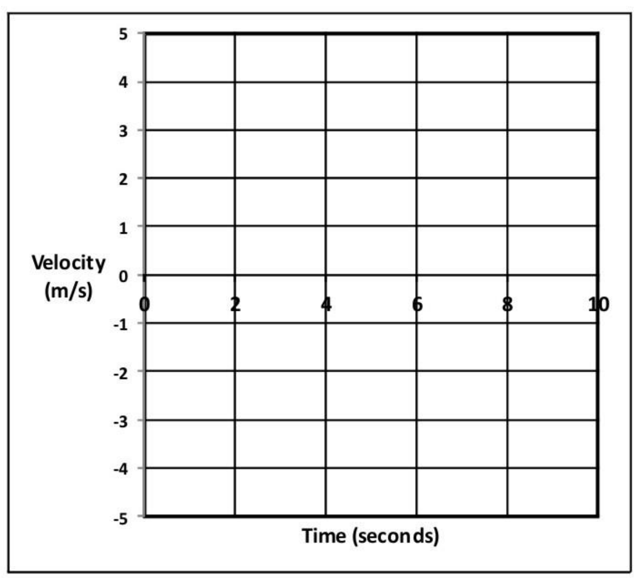
Δt = _________

$\mathbf{v}_{\mathbf{average}}$ = __________

Distance traveled = ___________

Position at end of segment = ____________

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



Position vs. Time Motion Matching Activity Questions:

On a <u>motion sensor</u> graph of position vs. time…

1. What does a positive (upward) slope tell you about the object's motion?

2. What does a negative slope indicate?

3. What does the steepness of a slope tell you about the object's motion?

4. What does a constant (straight line) slope indicate?

5. What might a smoothly curving line indicate?

6. Sketch a negative slope that is becoming less steep. What does this curve indicate about the motion of an object?

7. Sketch a negative slope that is getting steeper. What does this curve indicate about the motion of an object?

8. Sketch a positive slope that is becoming less steep. What does this curve indicate about the motion of an object?

9. Sketch a positive slope that is getting steeper. What does this curve indicate about the motion of an object?