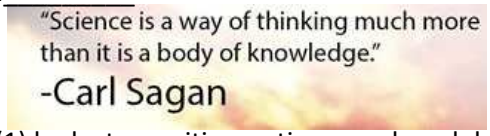
Name_____

Period_____

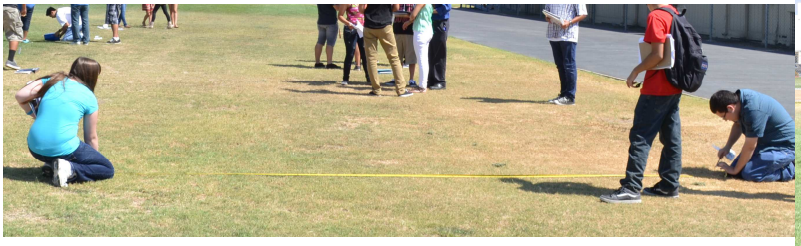


Lesson 2: Describing Motion with Words and Graphs

After completing the next few activities, you should be able to: (1) look at a position vs time graph and describe the motion of an object, (2) look at the motion of an object and sketch a graph representing that motion.

2.1 Experiment. Making Position vs Time Graphs

For parts a-c, (1) first sketch your prediction with a dotted line then (2) plot your graphs on graph paper (attach them) and (3) sketch the graph you observe in each case with a solid line.



(a) Walk away from the origin slowly and steadily

PREDICTION: _ _ _ _ _ _ _ _

position

time

ACTUAL: ——————

position

time

(b) Walk away from the origin medium fast and steadily

PREDICTION: _ _ _ _ _ _ _ _

position

time

ACTUAL: ——————

position

time

(c) Start at the other end and walk toward the origin slowly and steadily

PREDICTION: _ _ _ _ _ _ _ _

position

time

ACTUAL: ——————

position

time

(a) Interval #	Displacement during this one interval (m)	Duration (time) of this one interval (s)	Average speed during interval (m/s)	Position (m)	Total Time (s)
1	4m			0m	
2	4m			4m	
3	4m			8m	
4					
5					
6					
7					
8					
9					
(b) Interval #	Displacement during this one interval (m)	Duration (time) of this one interval (s)	Average speed during interval (m/s)	Position (m)	Total Time (s)
1	4m			0m	
2	4m			4m	
3	4m			8m	
4					
5					
6					
7					
8					
9					

(c) Interval #	Displacement during this one interval (m)	Duration (time) of this one interval (s)	Average speed during interval (m/s)	Position (m)	Total Time (s)
1	-4m				
2	-4m				
3	-4m				
4					
5					
6					
7					
8					
9					

(d) Use the data from each of your trials to fill in the tables above.

(e) Describe the difference between the graph you made by walking away slowly and walking away more quickly.

(f) Is it possible for an object to move so that it produces an absolutely vertical line on a position time graph? Explain.

(g) Describe the difference between the graph made by walking toward the origin and walking away from the origin.

2.2 Experiment: Predicting a Position vs Time Graph

(a) Suppose you were to

start 4m in front of the origin and walk away steadily at a moderate speed for 10 seconds until you are 32m away,

then stop for 3 seconds,

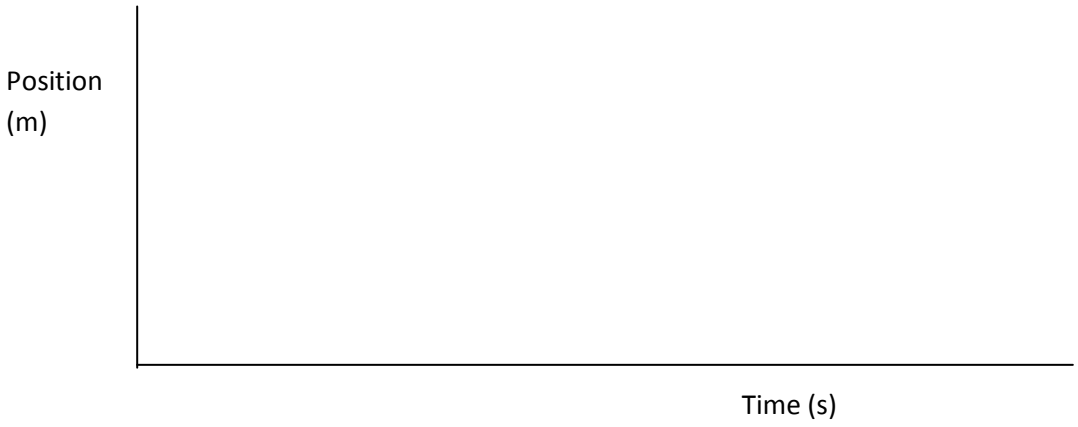
and then walk/jog toward the origin quickly for 5 seconds so that you are back where you started.

Sketch your prediction on the set of axes below:

PREDICTION:

(b) Test your prediction by **actually moving in the way described** above and using the data you collect to graph your actual motion. Sketch the shape of your actual motion graph on set of axes below.

ACTUAL:



Interval #	Displacement during this one interval (m)	Position (m)	Total Time (s)
1	4m	4m	
2	4m	8m	
3	4m	12m	
4		16m	
5		20m	
6		24m	
7		28m	
8		32m	
9		32m	
10		28m	
11		24m	
12		20m	
13		16m	
14		12m	
15		8m	
16		4m	
17		0m	

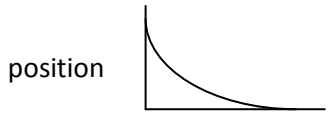
(c) Was your prediction the same as the final result? Describe how you would move to make a graph that looks like your prediction.

2.3 Matching Position vs Time Graphs

(a) **PREDICT**: How would you have to move to produce curved position vs time graphs shaped like this?

GRAPH 1

To make GRAPH 1 (shown above) I PREDICT that I will have to move like this:



GRAPH 2

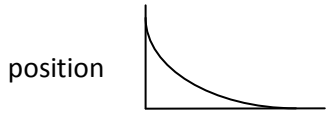
To make GRAPH 2 (shown above) I PREDICT that I will have to move like this:

(b) Now move in such a way as to produce the shapes shown above and graph this data on graph paper. Attach your data tables and graphs.

(c) Describe how you had to move to produce a position vs time graph with each of the shapes shown.

GRAPH 1

To make GRAPH 1 (shown above) I ACTUALLY moved like this:



GRAPH 2

To make GRAPH 2 (shown above) I ACTUALLY moved like this:

(d) What is the general difference between motions which result in a **straight-line** position vs time graph and those that result in a **curved-line** position vs time graph?

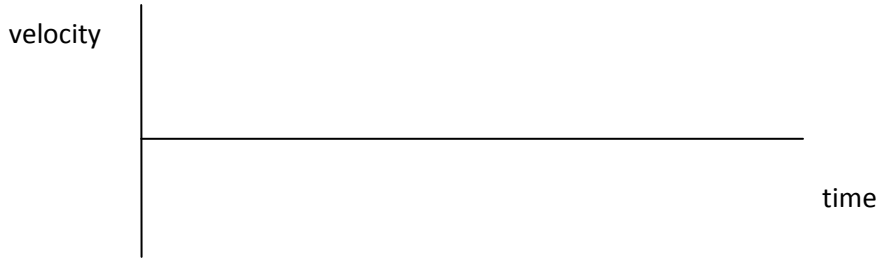
2.4 Experiment: Making Velocity vs Time Graphs

(a) Use your data from 2.1 parts a-c to make velocity graphs of all three graphs by subtracting pairs of positions and times as described in class (fill in the values from the table in 2.1). Use the change in position and change in time data to create them. Attach any relevant data.

A. Walk away from the origin slowly and steadily

B. Walk away from the origin medium fast and steadily

C. Start at the other end and walk toward the origin slowly and steadily

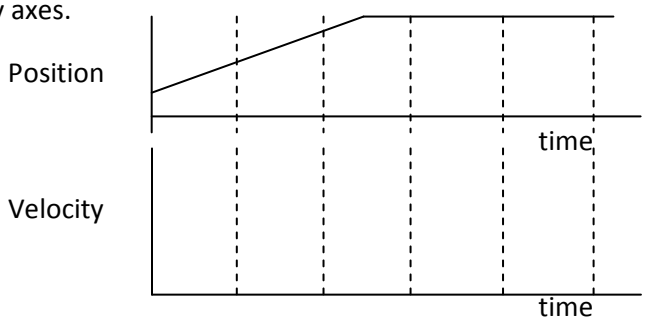


(b) What is the most important difference between the graph made by slowly walking away from the detector ("up" the field) and the one made by walking away more quickly?

(c) How are the velocity vs time graphs different for motion away ("up" the field) and motion toward ("down" the field) the detector?

2.5 Experiment: Predicting Velocity Graphs from Position Graphs

(a) Carefully study the position graph shown below and predict the velocity vs time graph that would result from the motion. Using a dashed line, sketch your **prediction** of the corresponding velocity vs time graph on the velocity axes.



PREDICTION: – – – – – – – –

ACTUAL: ——————

(b) After each person in your group has sketched a prediction, test your prediction by matching the position vs time graph shown. Use the table below to help you keep track of your data:

Interval #	Displacement during this one interval (m)	Duration (time) of this one interval (s)	Average speed during interval (m/s)	Position (m)	Total Time (s)
1	4m			0m	
2	4m			4m	
3	4m			8m	
4					
5					
6					
7					
8					

(c)Use a solid line to draw the actual velocity graph on the same graph with your prediction. Do not erase your prediction.

(d) How would the **position** graph be different if you moved faster?

(e) How would the **position** graph be different if you moved slower?

(f) How would the **velocity** graph be different if you moved faster?

(g) How would the **velocity** graph be different if you moved slower?

2.6 Exercise: Average Velocity Calculations

(a) Find the average value of the velocity from one of your horizontal velocity graphs (while you were moving) by adding your velocities together and dividing by the number of velocities you have:

Average value of the velocity: _____ m/s using motion from 2.____ (____)

Average velocity can also be calculated as the change in position divided by the change in time, <v> = Δx/Δt (by definition, the slope) which is a quantitative measure of the steepness of the graph.

(b) Use the method described just above to calculate your average velocity from the slope of the position vs time graph. Use two points as far apart as possible, ***but from times while you were still moving***.

(c) Calculate the change in position between points 1 and 2. Also calculate the corresponding change in time. Divide the change in position by the change in time to calculate the average velocity.

Position1: _____ m Position 2: _____ m Time1:_____ s Time2:_____ s

Change of Position = (Position2 – Position1) = _____ s

Change of Time = (Time2 – Time1) = _____ s

Velocity = (Change of Position) / (Change of Time) =

Average value of the velocity using the slope: _____ m/s

(d) Is the average velocity positive or negative?

(e) Is this what you expected? Explain.

(f) Does the average velocity you just calculated from the position graph agree with the average velocity you estimated from the velocity graph in part (a)? (In other words, are they the same or close to the same?)

(g) Do you expect them to agree? Explain.

(h) How would you account for any differences?