Experiment 2 -part 1A
MOTION: Distance Graphs

EQUIPMENT

Motion detector
Notebook
Motion program

Name: _________________________

Section: ________________________

INTRODUCTION

In this investigation, you will use a motion detector to measure how you move. As you walk (or skip, or jump, or run) the graph on the computer screen displays how far away from the detector you are.

We will make distance/time graphs for different walking speeds and directions. Place the motion detector on top of 2 stacked stools.

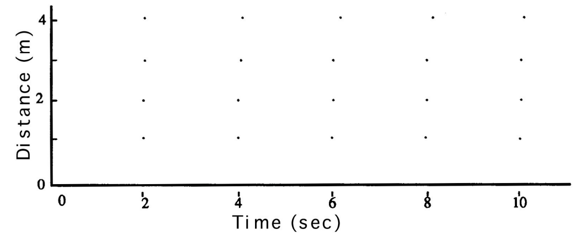
Hold a notebook or piece of paper at the level of the motion detector as you move. This provides a more uniform reflection surface.

PROCEDURE

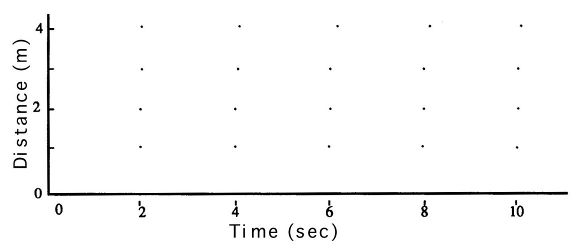
A. Making Distance Graphs

1. Select the MOTION experiment. The Logger Pro application should open.

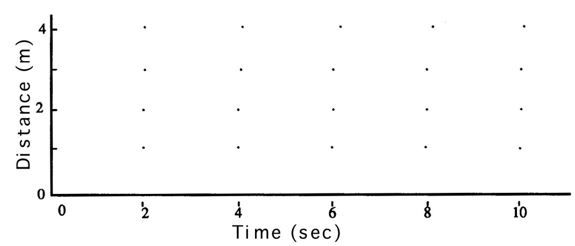
2. Start at the 1/2-meter mark and make a distance/time graph by clicking COLLECT and walking *slowly* away from the detector. Sketch the graph below. Be sure to note the values on the axes.



3. Make a distance/time graph walking *slowly* toward the detector. Sketch the graph.

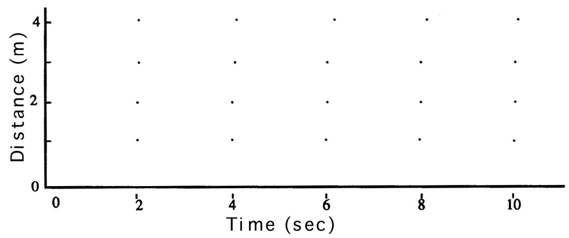


4. Make a distance/time graph walking medium fast toward the detector. Sketch the graph.



5. Make a distance/time graph, walking *medium fast* away from the detector. Sketch the graph below. You may run out of walking room before the 10

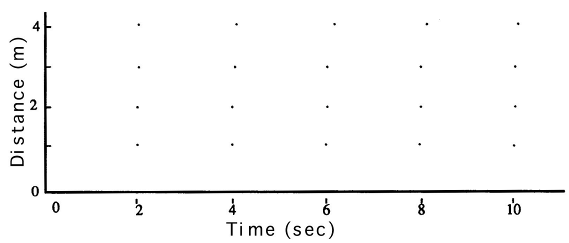
seconds runs out. Just draw the graph that reflects you walking away.



B. Predicting a Distance Graph

6. Each person draw below, using a dotted line, your prediction of the graph if a person starts at the 1-meter mark, walks steadily and slowly away, stops for 4 seconds, and then walks quickly back.

PREDICTION

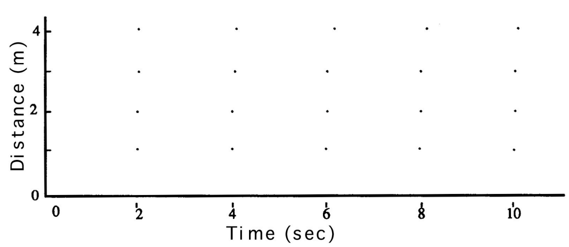


7. Compare predictions. See if you can all agree. Using the above graph draw with a solid line of the prediction your group agrees on.

8. Do the experiment.

9. When you are satisfied that you have walked correctly, draw your group's final result on the second paragraph.

FINAL RESULT



10. Is your prediction the same as the final result? If not, describe how you would move to make a graph that looks like your prediction.

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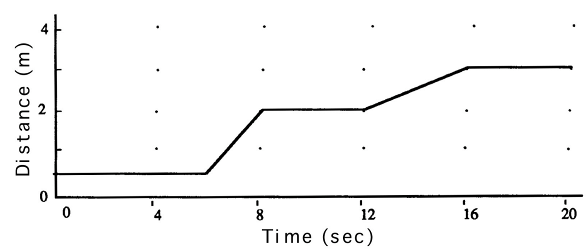
C. Match this Graph

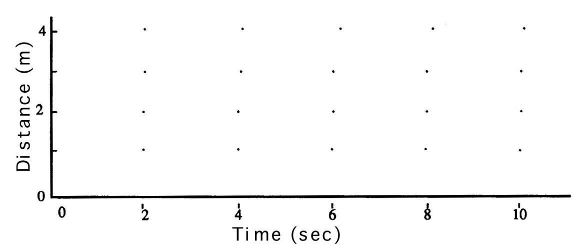
11. You will need to change the timescale to 20s. To change the timescale select SETUP from the main menu. Select DATA COLLECTION, then click the SAMPLING tab. In the field labeled EXPERIMENT LENGTH enter 20. Press the OK button in the lower right hand corner of the window.

12. Move so the computer displays this graph. You may try a number of times. Each person should take a turn.

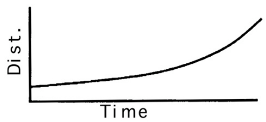


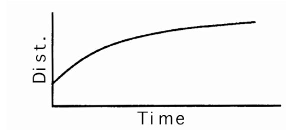
D. Challenges

13. If necessary, change the experiment length back to 10s. Make up your own distance graph. Turn the screen, if necessary, so that the walking person can see the screen. Use straight lines, no squiggles. Then see how well people in your group can duplicate on the screen the graph you draw.



14. Can you make a graph with **curved lines**? Try to make the shapes shown below. Did you succeed? How?





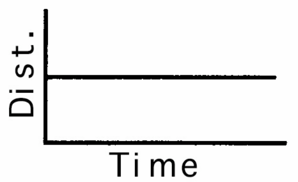
15. Close “Distance Graph”.

Experiment 2 -part 1A

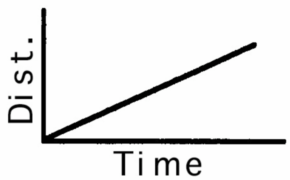
Distance: DATA SHEET

Name: ___________________________

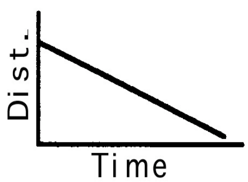
Section: ___________________________



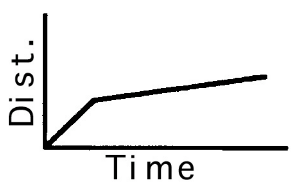
1. What do you do to create a horizontal line on a distance/time graph?



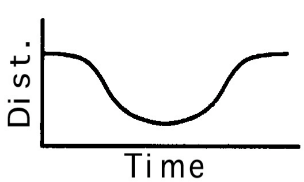
2. How do you walk to create a straight line that slopes up?



3. How do you walk to create a straight line that slopes down?



4. How do you move so the graph goes up steeply at first, and then continues up gradually?



5.How do you walk to create a U-shaped graph?

Experiment 2-part 1B
MOTION: Velocity Graphs

EQUIPMENT

Motion Detector
Notebook

Name: ___________________________

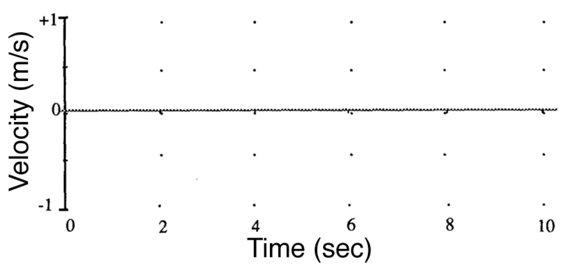
Section: _________________________

PROCEDURE

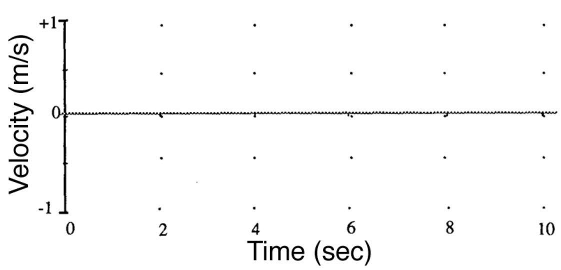
E. Making Velocity Graphs

16. Open file named "Velocity Graphs'.

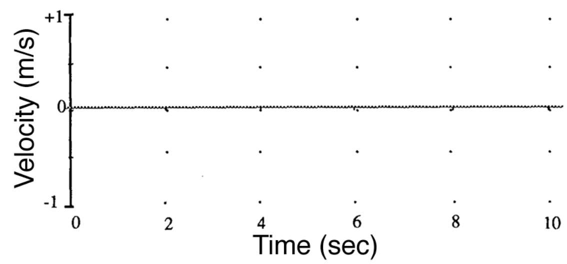
17. Make a velocity graph by walking slowly and steadily away from the detector. Try again until you get a graph you're satisfied with. Sketch the result here. (Just draw smooth patterns; leave out little wiggles and bumps).



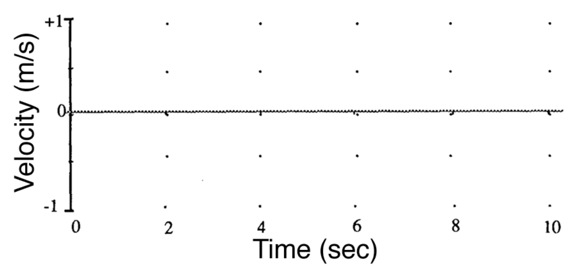
18. Make a velocity graph by walking *medium fast* and steadily away from the detector. Sketch your graph.



19. Make a velocity graph by walking slowly and steadily toward the detector. Sketch your graph.



20. Make a velocity graph by walking medium fast and steadily toward the detector. Sketch your graph.



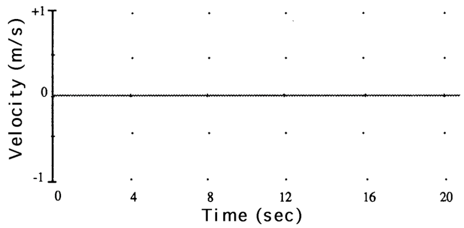
F. Predicting Velocity Graphs

21. Each person draw below, using a *dotted line, your prediction of* the velocity graph produced if you walk slowly and steadily away from the detector then

    stop for 4 seconds, then

    walk quickly back to the detector.

Prediction

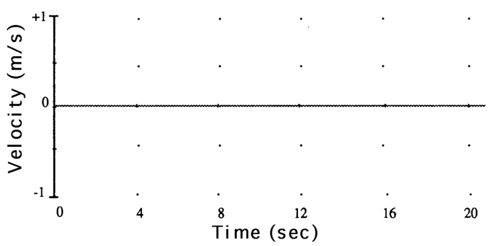


22. Compare predictions and see *if* you can all agree. Use a solid line to draw in your group prediction using the above graph.

23. Do the experiment. Change the experiment length to 20s as in part A. Repeat experiment until you create a graph that seems correct.

24. Draw the best graph on below. Be sure the 4-second stop shows clearly.

Final Result



G. Challenge: Beating a Burglar Alarm

25. Many burglar alarms work by using a motion detector to sense moving objects. Because these motion detectors are not very sensitive, you can fool one by moving very slowly.

26. Each member in the group should find how slowly you have to walk so the velocity graph barely registers your motion.

27. See how far you can move in 20 seconds without triggering the burglar alarm. Use the distance and velocity graphs. If the velocity graph moves more than a very small amount above or below the axis, you have triggered the alarm. Record each partner's best distance.

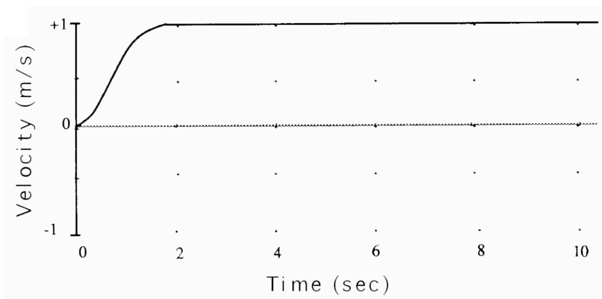
28.

Name	**Distance in 20 Seconds**
____________________	____________________
____________________	____________________
____________________	____________________

QUESTIONS

1. Describe clearly how to move to make each of the following three graphs. You may want to study the velocity graphs you made today to help you think about this.

Graph 1



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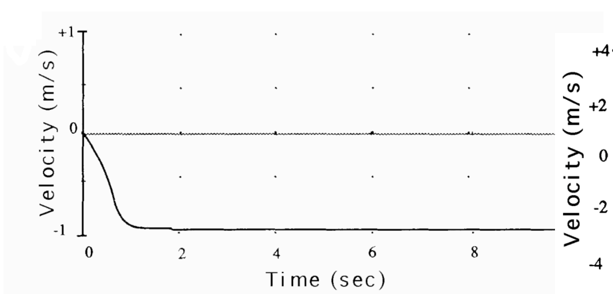
Graph 2



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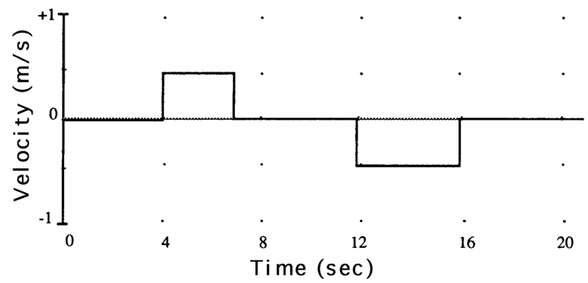
Graph 3



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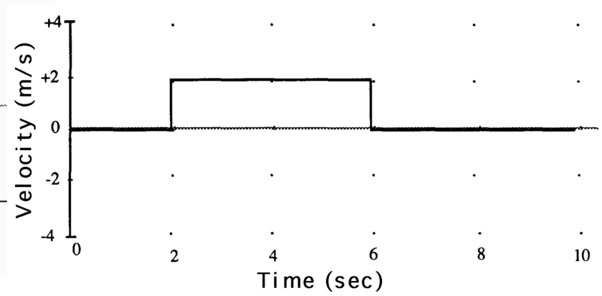
2. Figure out the *distance* the person traveled in the graph below (show your work).

Distance ______________ meters.



Experiment 2-Part 2

VELOCITY

EQUIPMENT

1 photogate	*1 race car with bar*
1 race track	*1 metric ruler*
Amadeus program	*2 meter length of string*
1 vernier caliper	*meter stick*

INTRODUCTION

The purpose of this experiment is to determine the velocity of a moving object by accurately measuring the time for the object to move a specified distance.
A simple slot car racing set can be used to demonstrate the basic principles of motion. In this experiment the racing set will be used to illustrate how velocity can be calculated from time and distance measurements. The relationship that will be used is:

Remember that velocity is a vector quantity so it has both *magnitude* and *direction*. Thus the velocity of a car going around the track cannot be constant because the direction of the car changes. The magnitude of the velocity (or speed) can be constant while the direction of the car changes. Likewise, the direction may be constant while the speed changes. Velocity is dependent upon both speed and direction. You can calculate the linear velocity of the car along a straight portion of the track. You can also calculate the lap speed which is unaffected by direction and takes into account the car's speed through all portions of the track. To calculate either velocity or speed it will be necessary to make measurements of time. Photogates can make very accurate time measurements. It is important that you become familiar with how to use the software since it will be used in this and other experiments.

PROCEDURE

A. Calculation of Linear Velocity

1. Set up a photogate along the length of the track.
2. Use the Vernier caliper to measure the width of the bar on top of the car.
3. Use the Amadeus program and the method described in Lesson 2 in Appendix E to measure the velocity of the car..
4. Run the car around the track until you have achieved a fairly constant speed. Now press RECORD as the car goes around the track. When you complete the data acquisition press STOP.
5. Record the time it takes the car to pass through the photogate. The time should be a small fraction of one second since this is the time the car takes to go about 1 cm.
6. Repeat steps 4 and 5 five more times trying to get different velocities each time.
7. Use a calculator to find the for each run to complete the table.
8. $$\text{velocity} = \frac{\text{length of the bar on the car}}{\text{time}}$$

B. Calculation of Lap Speed

9. Use a piece of string and a meter stick to find the distance around the track. To do this, lay the string in the track groove. Mark the string where it meets itself in the groove, remove the string, and measure this length with the meter stick.
10. Repeat the Time Data Collection technique to measure the time to complete one lap.
11. Run the racecar around the track until you have it at a constant speed. Press RECORD. Make at least 4 laps while trying to keep a constant speed. Press STOP. The time for one lap is the time between two successive positive vertical spikes.
12. Record the times in the data table. Complete the data table in the same way as in part A.
13. Calculate the average lap speed.

Experiment 2
DATA SHEET

Name: ___________________________

Section: __________________________

Table A. Length of bar on top of car = ________cm.

Time Between Vertical Spikes (sec)	Velocity Between Photogates (cm/sec)

Table B. Distance around the track =____________cm.

Time to Complete One Lap (sec)	Lap Speed (cm/sec)

Average Lap Speed = ________________________cm/sec.

QUESTIONS

1. If an object of length 5 cm passes through the photogate in a time of 0.50 seconds, what is the velocity of the object?

2. What is the difference in speed and velocity?

3. Why did we describe the measurement in Part B as a calculation of lap speed?

4. In its second lap a car takes twice as long to pass through photogate as it did on the first lap. What can you say about the speed of the car in the second lap?