Experiment 2
MOTION: Distance Graphs

EQUIPMENT	
Motion detector	*Lab Pro Interface*
Notebook	*Power supply*
Motion program	*USB cord*

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 at a given time.

Your primary task in this experiment is to *generate and interpret* two types of plots- **Distance vs. time** plots and **Velocity vs. Time** plots. Understanding the fundamental physics involves understanding the shape of these plots when motion occurs at a constant speed (i.e., motion with zero acceleration) and at a non-constant speed (i.e., accelerated motion). You should note that there are *two types of acceleration*-constant (e.g., acceleration of gravity) and non-constant (e.g., normal accelerating or braking in a car).

For Distance vs. time plots the primary behavior that you should know is that for objects traveling at constant speeds the plot is a **straight line** with a slope that represents the speed- *The greater the speed, the greater the slope, and vice versa*. For objects that accelerate, the distance vs. time yields **some type of curve** (e.g., a parabola in the case of constant acceleration).

Velocity vs. time plots are derived from distance vs. time plots and are constructed by picking a particular time (on the distance vs. time plots), finding the slope at that time (i.e., the speed at that time) and plotting these points.

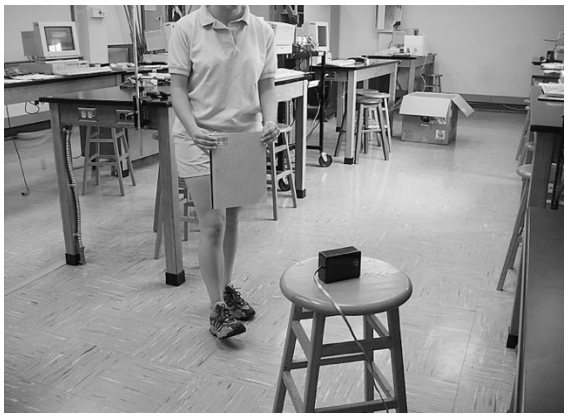
For objects traveling at constant speeds these plots have a constant slope and plot as a horizontal line. For objects traveling at a constant acceleration the slope at a particular time (i.e., the velocity) changes at a constant rate and as a consequence velocity vs. time plots as a *straight line* with a non-zero slope.

We will make distance/time graphs for different walking speeds and directions. Place the motion detector on top of two stacked stools. Hold a notebook or piece of paper at the horizontal level of the motion detector as you move. This provides a more uniform reflection surface.

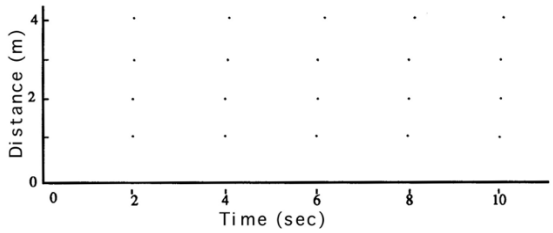
PROCEDURE

A. Making Distance Graphs

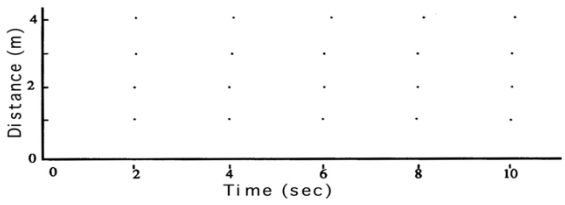
1. Select the MOTION experiment. The Logger Pro application should open.



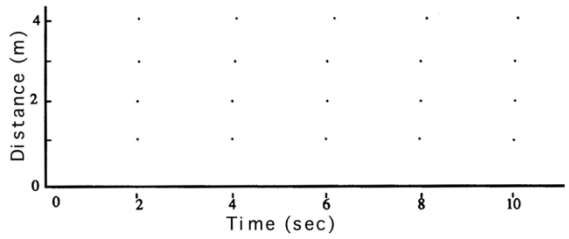
2. Start at the 1/2-meter mark and make a distance/time graph by clicking COLLECT and walking *slowly away* from the detector. Sketch the graph below. Be sure to note the values on the axes.



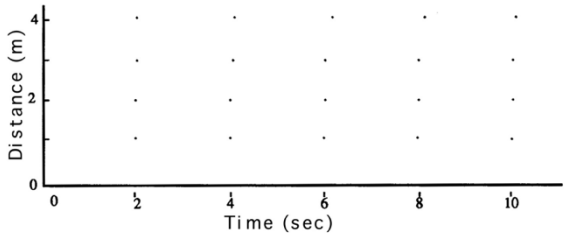
3. Make a distance/time graph walking *slowly towards* the detector. Sketch the graph.



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



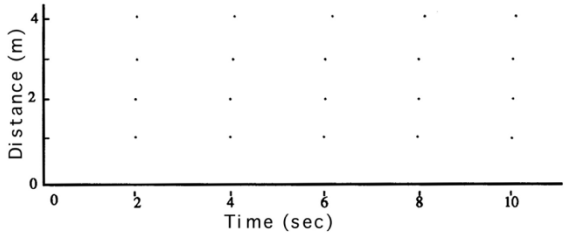
5. Make a distance/time graph, walking *medium fast* away from the detector. Sketch the graph below. You may run out of walking room before the 10 seconds runs out. Just draw the graph that reflects you walking away.



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

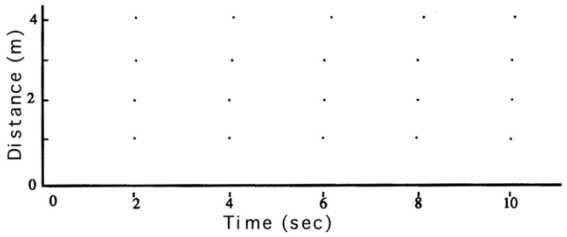


7. Compare predictions. See if you can all agree. Using the above graph draw with a solid line of the prediction your group agrees on.

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.

_____

_____

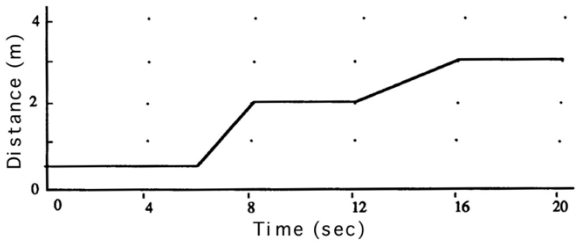
_____

_____

C. Match this Graph

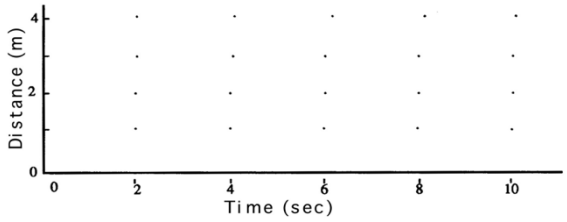
11. You will need to change the timescale to 20s. To change the timescale, click the last number on the horizontal scale and type 20 in its place.

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



D. Challenges

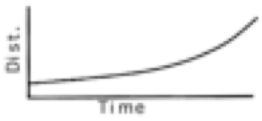
13. If necessary, change the experiment length back to 10s. Make up your own distance graph. Turn the screen, if necessary, so that the walking person can see the screen. Use straight lines, no squiggles. Then see how well people in your group can duplicate on the screen the graph you draw.



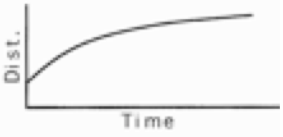
14. **Can you make a graph with curved lines?**

    Try to duplicate the shapes below.

Graph A



Graph B



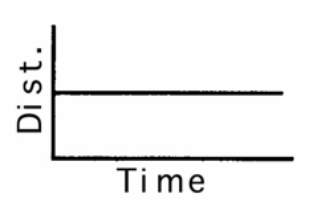
Graph A:
Did you succeed? _____
How? _____
_____
Graph B:
Did you succeed? _____
How? _____
_____

15. Close “Distance Graph”

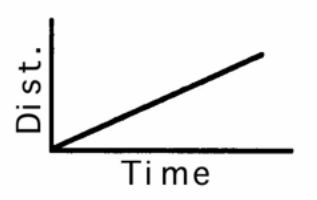
Experiment 2
Distance: DATA SHEET

Name: _____

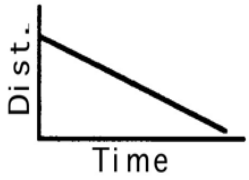
Section: _____



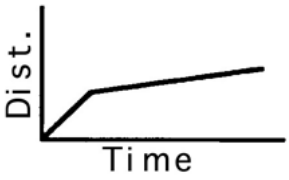
1. What do you do to create a horizontal line on a distance/time graph?



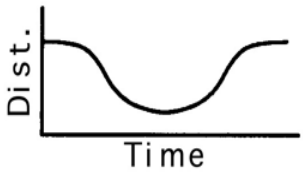
2. How do you walk to create a straight line that slopes up?



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
MOTION: Velocity Graphs

EQUIPMENT

Motion Detector
Notebook

Name: _____

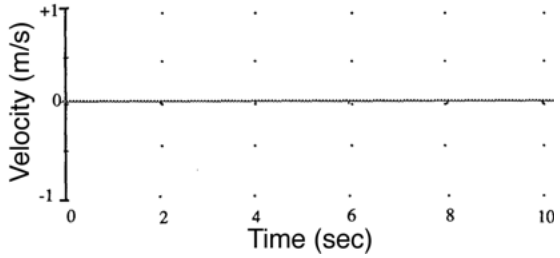
Section: _____

PROCEDURE

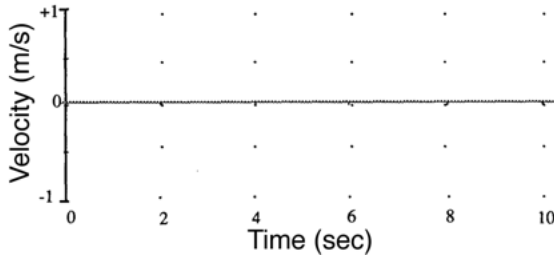
E. Making Velocity Graphs

16. Open file named "Velocity Graphs".

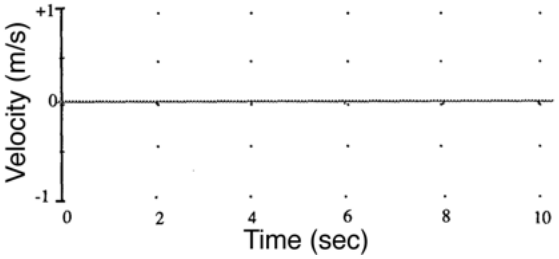
17. Make a velocity graph by *walking slowly* and *steadily* away from the detector. Try again until you get a graph you're satisfied with. Sketch the result here. (Just draw smooth patterns; leave out little wiggles and bumps).



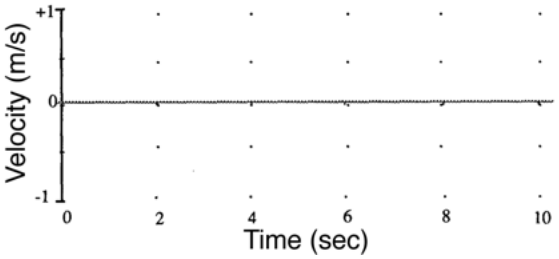
18. Make a velocity graph by walking *medium fast* and steadily away from the detector. Sketch your graph.



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.

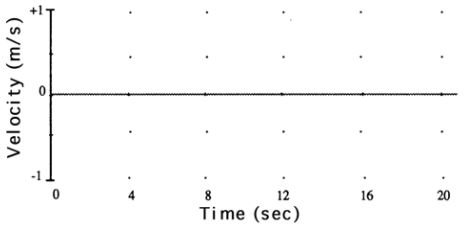


F. Predicting Velocity Graphs

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

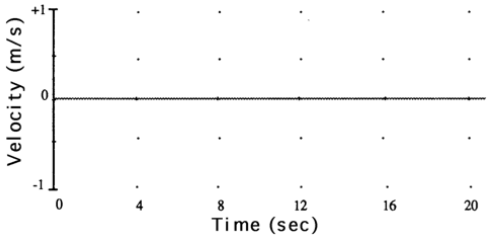


22. Compare predictions and see if you can all agree. Use a solid line to draw in your group prediction using the above graph.

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 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.

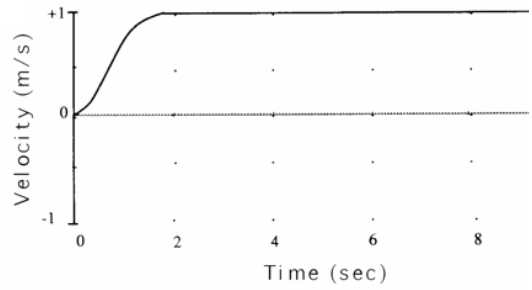
28.

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

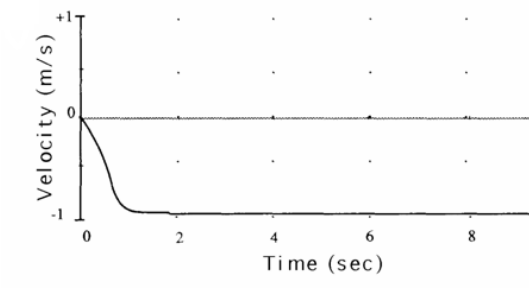


_____

_____

_____

Graph 2

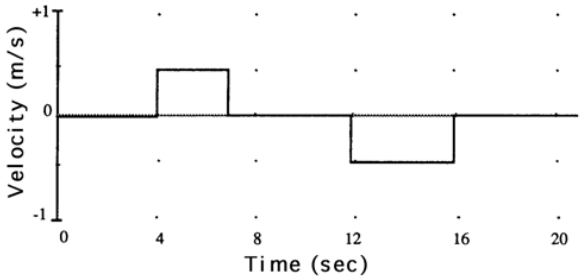


_____

_____

_____

Graph 3



_____

_____

_____

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

Distance _____ meters.