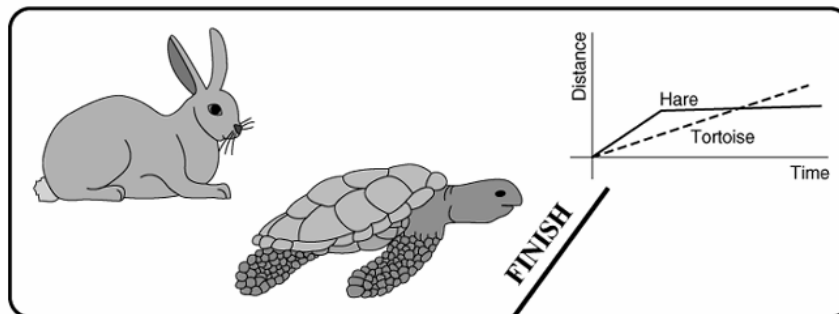


Name _____ Date _____ Partners _____

INTRODUCTION TO *DATASTUDIO* AND ONE-DIMENSIONAL MOTION



Slow and steady wins the race.

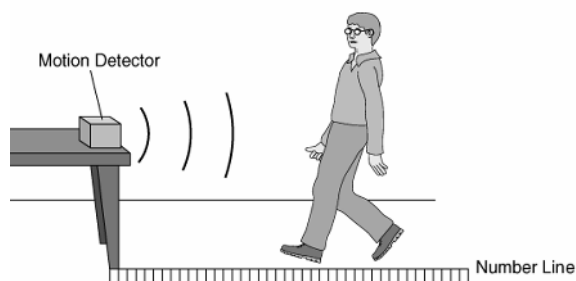
—Aesop's fable: The Hare and the Tortoise

OBJECTIVES

- To discover how to use a motion detector.
- To gain familiarity with the software program *DataStudio*
- To explore how various motions are represented on a distance (position)—time graph

OVERVIEW

In this lab you will begin your examination of the motion of an object that moves along a line and how it can be represented graphically. You will use a motion detector to plot distance (position)—time motion of your own body. The study of motion and its mathematical and graphical representation is known as *kinematics*.



INVESTIGATION 1: DISTANCE (POSITION)—TIME GRAPHS OF YOUR MOTION

The purpose of this investigation is to learn how to relate graphs of distance as a function of time to the motions they represent.

You will need the following materials:

- motion detector
- number line on floor in meters

Questions to consider:

How does the distance—time graph look when you move slowly? Quickly? What happens when you move toward the motion detector? Away? After completing this investigation, you should be able to look at a distance—time graph and describe the motion of an object. You should also be able to look at the motion of an object and sketch the distance—time graph.

Comment: “Distance” is short for “distance from the motion detector.” The motion detector is the origin from which distances are measured. The motion detector

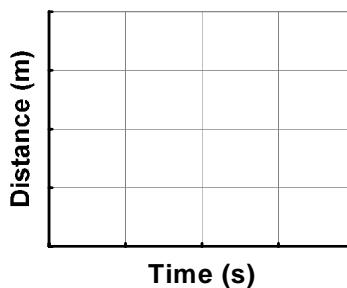
- detects the closest object directly in front of it (including your arms if you swing them as you walk).
- transfers information to the computer via the interface so that as you walk (or jump, or run), the graph on the computer screen displays your distance from the motion detector.
- will not correctly measure anything much closer than 20 cm. When making your graphs don't go closer than 20 cm from the motion detector.

Activity 1-1: Making and Interpreting Distance—Time Graphs

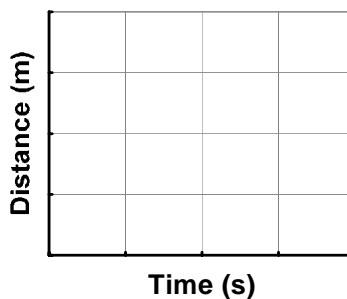
1. Be sure that the interface is connected to the computer. Start *DataStudio*. Click on *Create Experiment* on the opening page or under File, click on New Activity, which will go to the page where you can click on *Create Experiment*.
2. Under Sensor, find the Motion Sensor line, double click on the Icon beside the Motion Sensor line, and the software will connect the Motion Sensor to the 750 Interface. You should physically have the Motion Detector plugged into the Interface in the same manner. Note the colors on the cables. Close the Setup by clicking on the X in the upper right.
3. On the left side of the screen under Data, click on Position and drag it down to the graph icon in the display window. A graph should appear on the right side of the screen displaying Position vs. Time.
4. Note that you can change the scale on both axes by moving the mouse to the numbers, click and drag them to decrease or increase the scale. Try this for both scales.
5. To start the experiment, click on the Start button. Notice then that this button is replaced by a Stop button that allows you to stop the experiment.
6. You can erase data by clicking on Experiment on the top row and then clicking on Delete Last Data Run. Be careful of Deleting All Data if you don't mean to do so.
7. Check that the switch on the motion detector is on the “broad” beam.
8. Hit “start” and make distance—time graphs for different walking speeds and directions, and sketch

your graphs on the axes below. You may want to hold up a book or lab manual to provide a more reflective surface for the motion detector sensor.

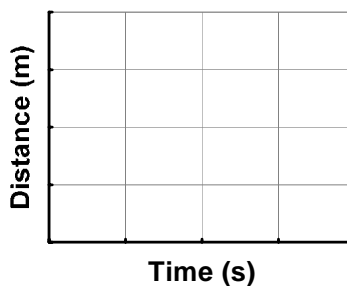
- a. Start at the $\frac{1}{2}$ meter mark and make a distance-time graph, walking away from the detector (origin) slowly and steadily.



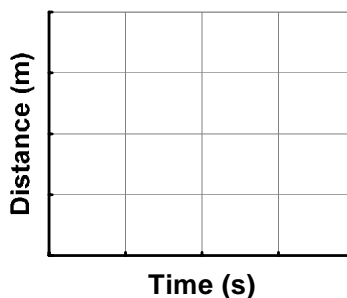
- b. Make a distance-time graph, walking away from the detector (origin) medium fast and steadily.



- c. Start at the 2 meter mark and make a distance-time graph, walking toward the detector (origin) slowly and steadily.



- d. Make a distance-time graph, walking toward the detector (origin) medium fast and steadily.



Question 1-1: Describe the difference between a graph made by walking away slowly and one made by walking away quickly.

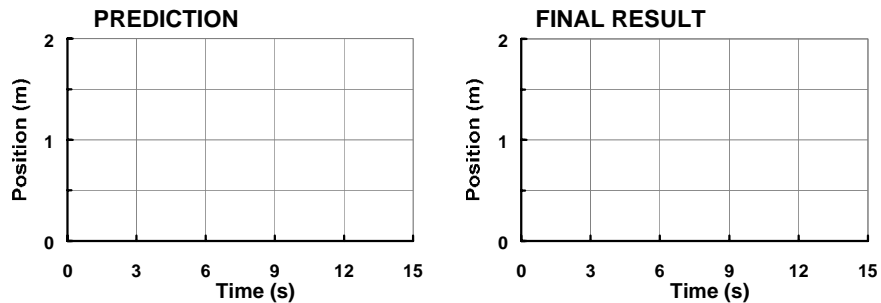
Question 1-2: Describe the difference between a graph made by walking *toward* and one made by walking *away* from the motion detector.

Comment: If you do not erase the graph, it will remain stored in the computer so that it is **persistently displayed on the screen**. You can also go to the Data icon and click on and off this run so the data is or is not displayed.

Once you have answered questions 1-1 and 1-2 and sketched your graphs, you should delete your data.

Prediction 1-1: Predict the position—time graph produced when a person starts at the 1 m mark, walks away from the detector slowly and steadily for 5 s, stops for 5 s, and then walks toward the detector twice as fast. Draw your prediction on the left diagram below using a *dashed* line.

Compare your predictions with those made by others in your group. Draw your group's prediction in the left-hand diagram below using a *solid* line. (Do not erase your original prediction.)



9. Test your prediction by using the computer to graph your position over a range of 2 m for a time interval of 15 s. Move in the way described in Prediction 1-1, and graph your motion. When you are satisfied with your graph, draw your group's final result on the right diagram above.

Question 1-3: 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*.

10. Keep the previous data of your motion on the screen. Change scales as desired or use the "Scale to Fit" icon on the Graph window toolbar on far left. Select "Scale to Fit" to see what happens.
11. Click on the Smart Tool and drag the crosshair to individual data points to read the position/distance at that point in time.
12. To highlight regions of data, go to beginning spot, click and drag a window around the region of interest. Data will be highlighted with yellow background. Highlight the first region of data when you walk away from the motion detector.
13. To fit data, click on the Fit icon and choose the function you desire, in this case Linear Fit. Note the parameters (slope and y-intercept) are immediately given on the screen. To remove them, go back and click on Linear Fit.

14. Note that if you leave Linear Fit on, but choose a different highlighted region, the fit will be applied to the new region.
15. Let's now examine the region where the person was at rest. Highlight the second region of your data which should be level. Then click on the Statistics icon (which appears as a Σ). Click on Mean and the mean value over that region will be displayed. Note the varying functions that can be obtained with the Statistics functions.
16. If you have multiple runs on the screen, note that the various tools work on the run that is highlighted in the box in yellow. You can choose which data runs are displayed by clicking on the Data icon and click on and off the runs as you desire.
17. Now find the slopes of the two regions in which you were walking. Remember that the return path was supposed to be twice as fast as the initial path. Use the Tools to find the velocity (slope) of each path:

First path slope: _____

Second path slope: _____

Question 1-4: How did you do? Was the speed in the second path twice that in the first? Explain.

INVESTIGATION 2: POSITION – TIME GRAPHS OF MOTION

The purpose of this investigation is to learn how to relate graphs of position as a function of time to the motions they represent.

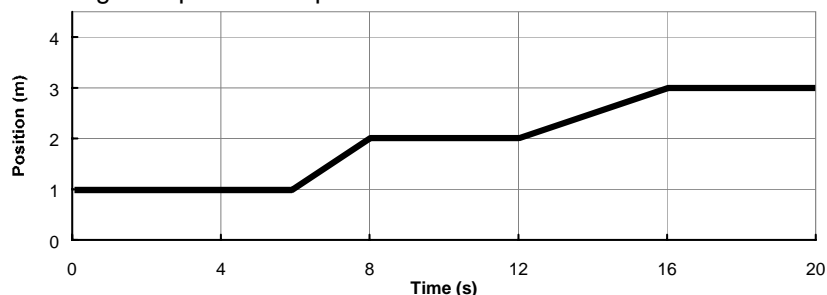
You will need the following materials:

- motion detector
- number line on floor in meters

Activity 2-1: Matching a Position—Time Graph

By now you should be pretty good at predicting the shape of a position—time graph of your movements. Can you do things the other way around: reading a position—time graph and figuring out how to move to reproduce it? In this activity you will move to match a position graph shown on the computer screen.

1. Open the experiment file called **Position Match L1.A2-1** located in the **635** folder. Do not try to save the previous activity. A position graph like that shown below will appear on the screen. Clear any other data remaining from previous experiments.



Comment: This graph is stored in the computer so that it is **persistently displayed on the screen**. New data from the motion detector can be collected without erasing the **Position Match** graph.

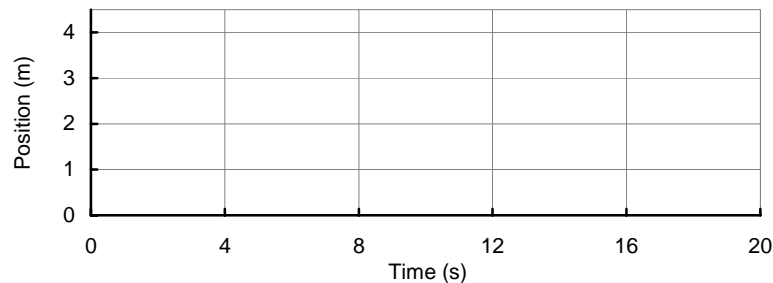
2. Try to move so as to duplicate the **Position Match** graph on the computer screen. You may try a number of times. It helps to work as a team. Each person should take a turn.

Question 2-1: What was different in the way you moved to produce the two differently sloped parts of the graph you just matched?

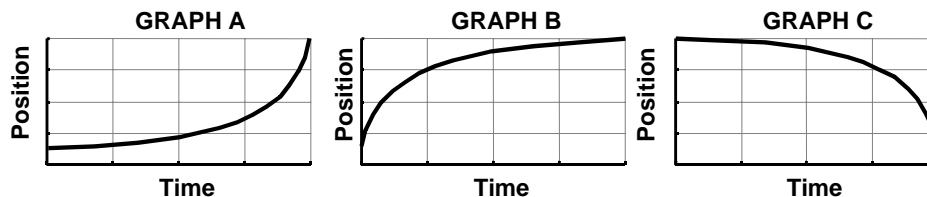
Activity 2-2: Other Position—Time Graphs

In this activity you will try to match the motion as drawn by one of your partners.

1. Make up your own position—time graph and sketch it on the axes below, using a dashed line. Use straight lines, no curves.



2. Now see how well someone in your group can duplicate this graph on the screen by walking in front of the motion detector. Open the experiment file **Partner Match L1.A2-2**. Draw the best attempt by a group member to match your position—time graph on the same axes. Use a solid line. Each person in the group should try one of their partner's graphs once.
3. Can you walk a curved position—time graph? Try to match each of the graphs shown below. Each group member should try one of these.



4. Describe how you must move to produce a position—time graph with each of the shapes shown.

Graph A answer:

Graph B answer:

Graph C answer: