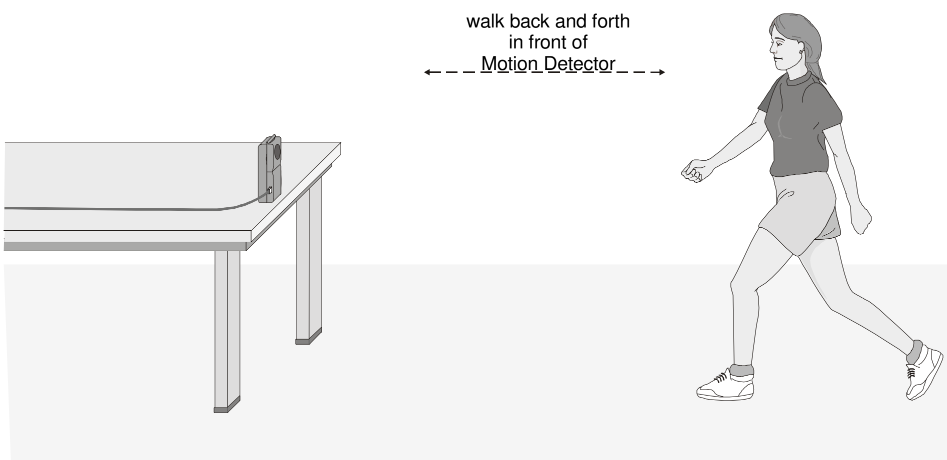
One Dimensional Kinematics

Introduction

The purpose of this lab is to develop an intuitive understanding of the graphs of position & velocity as a function of time. Graphically, we can interpret the velocity as the slope of the position function. Thus from having the graph of the position function, we can determine the graphs of the velocity function. We will make use of this idea to ***produce graphs with certain properties*** using a sonic motion detector.

Equipment Needed

Vernier LabPro® (LP) Interface, Computer, Sonic Motion Detector



Background Information

Our procedure will be to record the position as a function of time using ourselves as the object of study. We will measure our position as a function of time using the Vernier LabPro® interface and a sonic motion detector. The sonic ranger makes use of the fact that sound travels at a constant speed through the air in order to measure distances. The sonic ranger measures position by emitting a brief pulse of ultrasound (frequency = 40,000 kHz) towards a target and then detecting the sound reflected from the target. The sonic ranger determines the time interval that passes between when the pulse of sound is emitted and the reflected sound returns. The distance is determined from $d = v_s t_r / 2$, where v_s is the speed of sound, and t_r is the time interval between when the sonic ranger emits a pulse of sound and when it detects the reflected sound. The result is divided by 2 because the time interval represents a round trip for the sound, and is thus double the distance to the target. The speed of sound depends on the temperature, but at room temperature, the speed is approximately 343 m/s, and this is the value used by the sonic ranger in determining distances.

Set Up Procedure

The experimental set up is shown in **Figure 1.1.** To set up the apparatus, plug the USB cable from the LabPro Interface into the computer. (The LabPro Interface is located in one of your table drawers). Now connect the wide telephone type plug from the sonic motion detector into the LabPro socket labeled "Dig/Sonic 2". Place the sonic motion detector on the edge of the table in a position such that the sonic ranger has an unobstructed view of you walking towards and away over a distance of several meters. Note: the sonic ranger will not allow you to measure distances of less than .5 m or greater than 5 m.

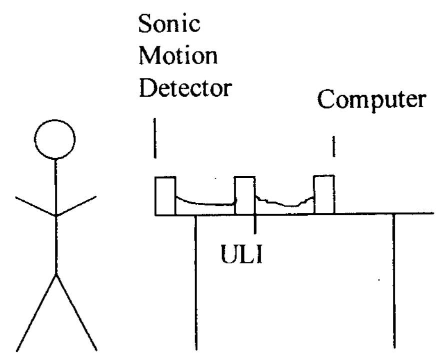


Figure 1.1

Data Acquisition

Launch the Logger Pro program by double clicking on the Logger Pro icon located in the left column of icons on your computer screen. Wait for the application to open. Now click the **File** menu and select the **Open** menu item. Select the ***"Probes & Sensors"*** directory and then the ***"Motion Detector"*** subdirectory. In the ***"Motion Detector"*** subdirectory double click on the **Motion Detector** file

A set of three (3) blank graphs labeled Distance, Velocity and Acceleration vs. Time should appear. During the first portions of the lab we will only be interested in the Distance and Velocity graphs.

To test data acquisition, have someone in your group walk back and forth in front the sonic motion detector and click on the "Collect" button located on the upper part of the graph. The apparatus will collect data for the range of time indicated on the time axis of the plot. If you have trouble getting any of this to work, notify the lab assistant or your instructor.

Printing Graphs

To print graphs, simply click on the printer button on the Logger Pro tool bar. Always include your names on the graphs by entering them in the printing options dialog box.

Report Format

This is a group project. You will turn in ***one*** report worksheet with graphs ***per group***. Make sure that the name of each person in the group is put on the worksheet. After each part of the lab print the graph and include it in your group report.

Making Your Graphs & Worksheet

Now that we have got our apparatus working, we will construct the following graphs.

1. **POSITION** *increases* linearly with time.

Explain how you would move in order to achieve this result.	
Discuss among your group and then sketch in the space to the right what you think a graph of the **position vs. time** would look like for this picture.	
Discuss among your group and then sketch in the space to the right what you think a graph of the **velocity vs. time** would look like for this picture.	

Now record a DISTANCE and VELOCITY graph for linearly increasing distance

2. **POSITION** *decreases* linearly with time.

Explain how you would move in order to achieve this result.	
Discuss among your group and then sketch in the space to the right what you think a graph of the **position vs. time** would look like for this picture.	
Discuss among your group and then sketch in the space to the right what you think a graph of the **velocity vs. time** would look like for this picture.	

Now record DISTANCE and VELOCITY graphs for linearly decreasing distance

Matching Graphs

3. Go back to the ***"Motion Detector"*** subdirectory and double click on one of the Position Matching files. If asked to save changes click "NO."

   The point of this activity is to move in such a way that you reproduce the position versus time graph shown. Discuss among your group how you will have to move to reproduce the graph. Each person in the group should take a turn matching the graph.

4. Go back to the ***"Motion Detector"*** subdirectory and double click on one of the Velocity Matching files. If asked to save changes click "NO."
   The point of this activity is to move in such a way that you reproduce the velocity versus time graph shown. Discuss among your group how you will have to move to reproduce the graph. Each person in the group should take a turn matching the graph.

This completes the experiment.