Physics 100 Lab – Linear Motion

The purpose of this lab is to investigate linear motion and compare what distance as a function of time graphs and velocity as a function of time graphs look like. You use an ultrasonic motion detector, a computer, and your own body to do this.

During this lab, you work in groups of two or three per computer. One person works the computer, while another moves in front of the motion detector. The detector has a limited range of 0.5 – 6 meters, so this is the range in which you will work. You can walk back and forth, i.e. change direction, in front of the detector during the same run.

To start the computer program:
The software we use in this lab runs on several different types of computers. Determine which kind of computer your group is using and follow the directions below to launch the program and do a test run.

On the older Macs, use Macmotion:
1. Double-click the Mac hard drive icon.
2. Double-click Macmotion. (You may have to do this again if a window with another Macmotion icon opens.)
   A window with a blank graph opens.

To do an experiment run:
1. Select Display→2 graphs.
   Two graphs, one distance and one velocity, displays on the screen
2. Click Start.
   After a short delay, you hear the motion detector start clicking. This means it is taking data.
   Note: Never click the Zero button it will freeze the program. If this happens, quit the program by selecting File → Quit and start over. Never save any data when you quit.
   The graphical interpretation of your motion displays on the screen.
To clear the data, click Start again. You can also clear data using one of the clear commands in the Data menu. Do a couple of trial runs so that you get comfortable with how the detector works.

On the Power Macs and PCs, use Loger Pro:
1. Double-click the Loger Pro icon:
   A window with two blank graph opens.

To do an experiment run:
1. Click the Collect button:
   After a short delay, you hear the motion detector start clicking. This means it is taking data.
2. Start moving in front of the detector.
   The graphical interpretation of your motion displays on the screen.
To clear the data, click the Collect button again. You can also clear data using one of the clear commands in the Data menu. Do a couple of trial runs so that you get comfortable with how the detector works.

Part 1: Getting to Know the Motion Detector
Perform the following motion in front of the detector and be sure to look at both the distance and the velocity graphs of each motion on the screen at the same time.

- Walk uniformly, run uniformly, then do an erratic motion, i.e. skip, jump, hop, or dance.

1. Repeat one of the motions, make a sketch of both of your graphs below; don’t forget to include the scale (numbers) for your vertical axis. You may have to change the horizontal (Time) axis to match the one in this lab. You do not need to be exact nor detailed. The graph needs to show the general trend of your motion only. Note: You have to sketch your own motion; you can’t use your lab partner’s.
2. On your **distance graph**, mark and label where you were the *closest* to the detector and where you were the *furthest* from the detector.

3. On your **velocity graph**, mark and label where you moved the *fastest* and where you moved the *slowest*.

Part 1 Graphs

<table>
<thead>
<tr>
<th>Distance from Detector (meters)</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0   2   4   6   8   10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Velocity (meters/second)</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0   2   4   6   8   10</td>
</tr>
</tbody>
</table>
Part 2: Studying Position
In each activity for this part, draw what appears on the screen when you perform the “motion” specified. If there are multiple curves on each graph, be sure to label them.

Use the motion detector and your body to produce a graph that shows:
a) a constant 50 cm position.
b) a constant 275 cm position.

Graph for 2a & 2b

Use the motion detector and your body to produce a graph that shows:
c) an increasing position.
d) a decreasing position.
e) an increasing, then decreasing position.

Graph for 2c, d, & e
Part 3: Studying Velocity

In each activity for this part, draw what appears on the screen when you perform the “motion” specified. If there are multiple curves on each graph, be sure to label them.

Use the motion detector and your body to produce a graph that shows:

a) a slow constant (no acceleration) velocity while walking away from the detector.
b) a fast constant velocity while walking away from the detector.

Graph for 3a & b

Use the motion detector and your body to produce a graph that shows:
c) a slow constant (no acceleration) velocity while walking towards detector.
d) a fast constant velocity while walking towards the detector.

Graph for 3c & d
Part 4: Making Predictions

On the first graph below, predict what the curve would look like when a person starts at 0.5 meters, walks away from the detector with a slow constant velocity for 5 seconds, stops for 3 seconds and then walks towards the detector with a fast constant velocity. Then perform the actual motion and draw what it looks like on the second graph.

Part 4 Prediction

Part 4 Actual
**Part 5: Matching Motions**

1. Change your display so that only a blank distance vs time graph is on the screen.
2. Change your axis to match the ones in the graph below.
3. Move in front of the computer so that your motion matches the graph below as closely as possible.
4. Sketch your motion on top of the graph below.

![Distance vs Time Graph](image)

**Part 5: Distance Match**

5. Change your display so that only a blank velocity vs time graph is on the screen.
6. Change your axis to match the ones in the graph below.
7. Move in front of the computer so that your motion matches the graph below as closely as possible.
8. Sketch your motion on top of the graph below.

![Velocity vs Time Graph](image)

9. Which of the two graphs was easier to match? Why do you think that is?
Part 6: Questions about Motion
Please answer these questions:

1. What kind of motion shows a horizontal flat line on a distance vs time graph? I.e. how were you moving in relation to the detector?

2. What kind of motion shows an upward sloping line on a distance vs time graph? I.e. how were you moving in relation to the detector?

3. What kind of motion shows a downward sloping line on a distance vs time graph? I.e. how were you moving in relation to the detector?

4. How can you tell from a distance vs time graph that you are moving with constant velocity?

5. How can you tell from a velocity vs time graph that you are moving with constant velocity?

6. How can you tell from a velocity vs time graph that you are accelerating?