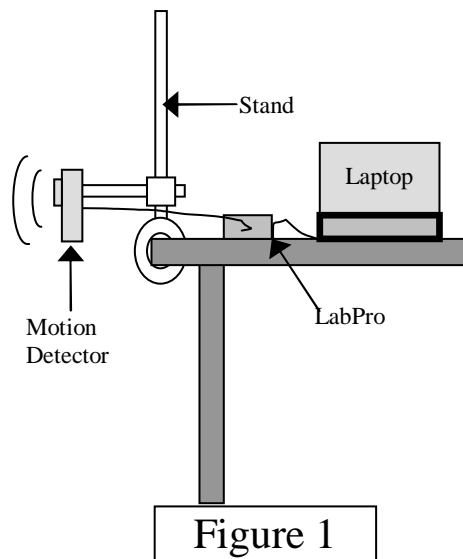


Motion Detector Lab

Introduction:

In this lab you will use a motion detector, hooked up to a computer to gain experience in interpreting “position vs. time” and “velocity vs. time” graphs. The motion detector uses sound waves to find the distance of an object in front of it at different times. This information is fed into the laptop which uses the software provided to plot the information in real time.



Setup:

Make sure that both the computer and motion detector are switched on and that the software is running. Take a few minutes to familiarize yourself with the software. Here are some important points:

1. To change number of graphs, go to the *View* menu and select *Graph Layout*.
2. To change the type of graph, click on the **y-axis label**.
3. To change the range of either axis, click on the axis and type in the maximum and minimum value **OR** click on the last number at either end of the axis.

Part 1: Familiarization with the Detector

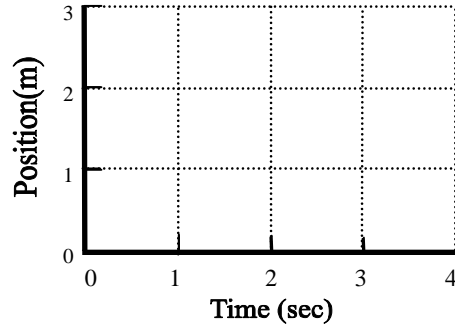
1. Set the program to display only one *position--time graph*.
2. Set the range of the Time axis to: 0 to 4 seconds.
3. Set the range of the Distance axis to: 0 to 2.5 meters
4. Have one person stand in front of the detector and have someone else push the *Collect* button in the program. Start to walk back and forth in front of the motion detector when it starts to make noise.
5. **Important:** There is a *minimum* and *maximum* distance for which the detector will work. By moving back and forth, find the *minimum* and *maximum* distances.
6. Try collecting data a few times just to get some experience with this setup. Give everyone in the group a chance to try it out.

Part 2: Position-Time Graphs

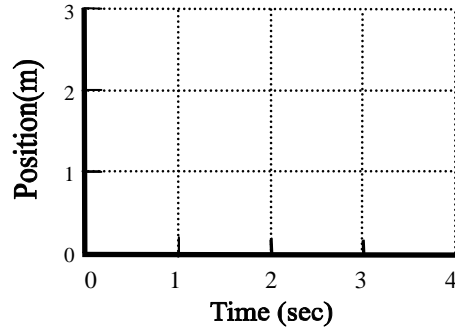
1. For each question below:
 - i. sketch a prediction of the *position-time* graph in the space provided
 - ii. produce the graph using the motion detector and sketch the result on the same graph in a different color.

Important: do not sketch the entire graph produced by the computer, just sketch the relevant part of the graph

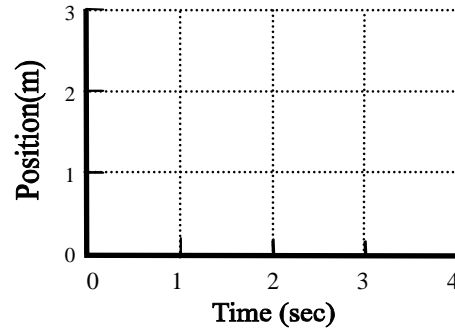
- a. Start at about $\frac{1}{2}$ meter from the detector and walk away from the detector *slowly and steadily*.



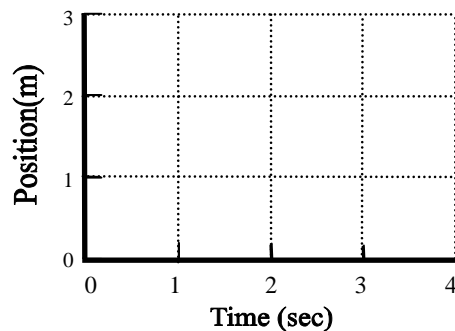
- b. Start at about $\frac{1}{2}$ meter from the detector and walk away from the detector *quickly and steadily*.



- c. Start at the **2 meters** from the detector and walk towards the detector *slowly and steadily*.



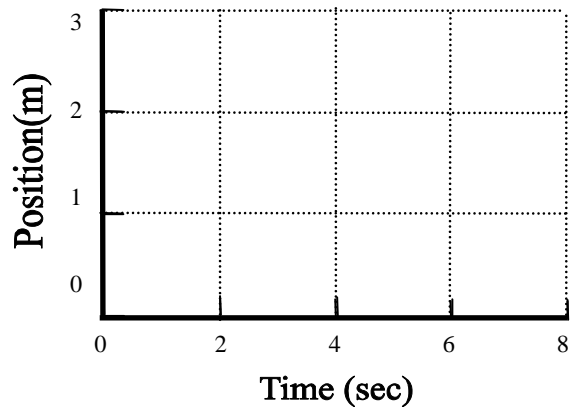
- d. Start at the **2 meters** and walk towards the detector *quickly and steadily*.



Name: _____
Section: _____

2. **Question:** How does the graph made by walking towards the detector *slowly* compare with the graph made by walking towards the detector *quickly*?
3. **Question:** How do the graphs made by walking towards the detector compare with graphs walking away from the detector?
4. Predict the *position-time* graphs for the situation described below. Sketch your predictions in the space provided and compare your prediction with the rest of your group. Next, produce the *position-time* graph using the motion detector and sketch the result in a different color.

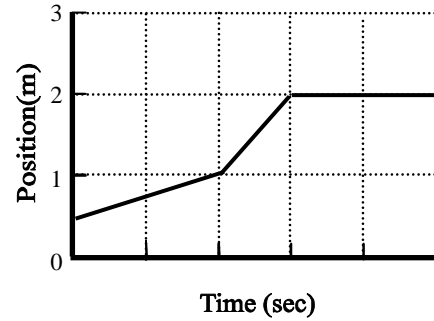
- a. Start at about $\frac{1}{2}$ meter from the detector
- b. Walk away from detector ***quickly and steadily*** for 1 second
- c. **Stop** for 2 seconds
- d. Walk towards detector ***very slowly and steadily*** for 2 seconds



5. **Important:** Show and explain the graph produced in the last Question to the TA and get their signature before moving on: TA Signature _____

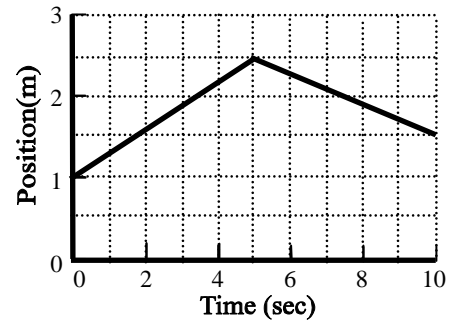
Name: _____
Section: _____

6. Write down in words the steps necessary to qualitatively produce the *position-time* graph shown on the right.



7. Try several times to re-produce the *position-time* graph shown above.
8. **Important: Show and explain the graph produced in the last Question to the TA and get their signature before moving on: TA Signature _____**
9. (207 labs only) For the graph on the right, use the slope to find the velocity:

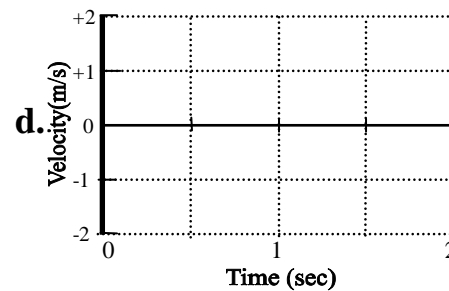
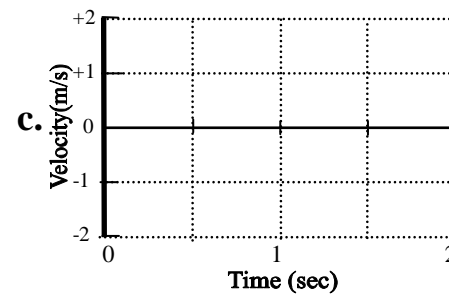
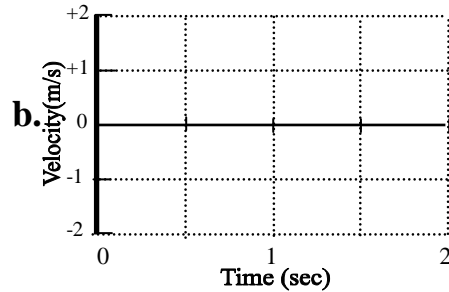
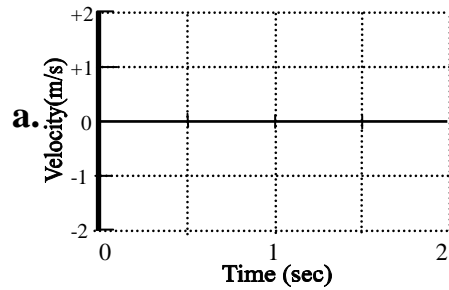
a. during the first 5 seconds



b. during the last 5 seconds

Part 3: Velocity-Time Graphs

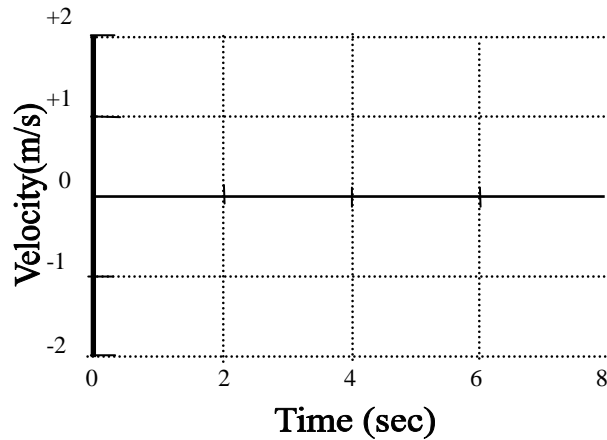
1. Change the graph to display only Velocity-time graphs with a velocity range from -2.0 m/s to 2.0 m/s.
2. Make *velocity-time* graphs for each of the types of motion described below. In each case, try producing the graph several times and sketch a reproduction of the graph in the space provided.
 - a. Start at about $\frac{1}{2}$ meter from the detector and walk away from the detector *slowly and steadily*.
 - b. Start at about $\frac{1}{2}$ meter from the detector and walk away from the detector *quickly and steadily*.
 - c. Start at **2 meters** and walk towards the detector *slowly and steadily*.
 - d. Start at the **2 meters** and walk towards the detector *quickly and steadily*.
3. **Question:** What is the difference between graphs made by walking **away slowly** and walking **away quickly**?



4. **Question:** What is the difference between graphs made by walking **steadily away from** the detector and **steadily towards** the detector
5. **Important:** Show and explain the your answers to the last 4 Questions to the TA and get a signature before moving on: TA Signature _____

Name: _____
Section: _____

6. Predict the *velocity-time* graph produced by the following motion and sketch your prediction in the area provide below. Then perform the actions and sketch the result in a different color.
- a. Start at the **2.5 meters** and walk towards the detector ***quickly and steadily*** for 1 second
 - b. **Stop** for 2 seconds
 - c. Walk away from the detector ***slowly and steadily*** for 2 seconds

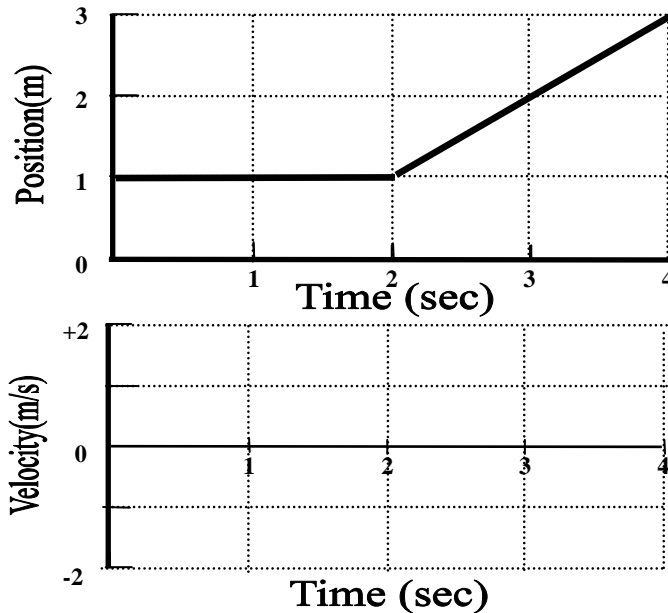


7. **Important:** Show and explain the graph produced in the last Question to the TA and get their signature before moving on: TA Signature _____

Part 4: Position-Time and Velocity-Time Graphs

Now we will relate *position-time* graphs to their corresponding *velocity-time* graphs.

1. Change the program to display 2 graphs, one for *position-time* and one for *velocity-time*. Set the range on both axes to be the same as the graphs below.
2. Predict the *velocity-time* graph that corresponds to the *position-graph* below, sketch it in the *velocity-time* graph provided.



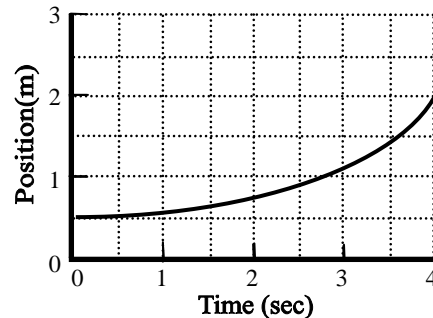
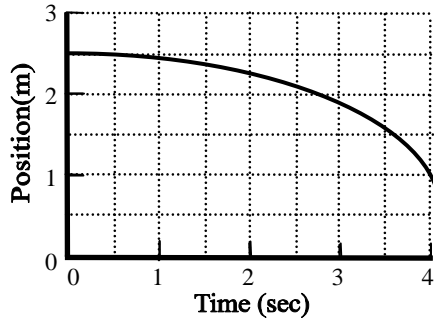
3. Now use the motion detector to reproduce the *position-time* graph above as closely as possible. Sketch the corresponding *velocity-time* graph using different color on the same graph as your prediction (do not erase your prediction).
4. **Important:** Show and explain the graph produced in the last Question to the TA and get their signature before moving on: TA Signature _____
5. **Question:** How would the *position-time* graph be different if you moved faster or slower?

6. **Question:** How would the *velocity-time* graph be different if you moved faster or slower?

Name: _____
Section: _____

Part 5: Acceleration

1. Use the motion detector to reproduce the curved line *position-time* graphs below as best as you can.

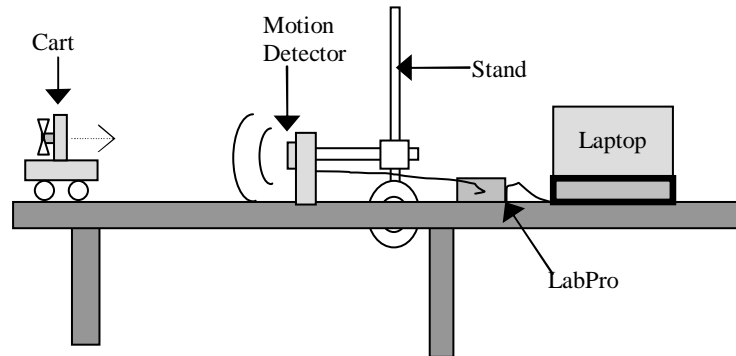


2. Describe how you moved to produce the 2 graphs.
3. **Important: Show and explain the graph produced in the last Question to the TA and get their signature before moving on: TA Signature _____**
4. **(207 labs only)** For the first graph, estimate the velocity at the following times: (HINT: use the slope of the tangent)
- a. $t=0$

 - b. $t=3$
5. **(207 labs only)** For the first graph, estimate the average acceleration between $t=0$ and $t=3$ seconds.

Part 7: Final question

1. Get a fan propelled cart from the TA and set up the motion detector to collect data for the cart's motion as it moves toward the detector as show in the diagram below.



2. Produce a *Position vs Time* and *Velocity vs. Time* graphs for motion of the cart accelerating towards the detector and sketch them in the space provide below.
3. **Important: Show and explain the graph produced in the last Question to the TA and get their signature before moving on: TA Signature _____**
4. (207 labs only) From the graph on the computer calculate the acceleration of the cart. Explain how you found the acceleration and show your work.