Date_____Pd_

Unit 2 CP Lab 3 - Motion Detector

Purpose: In this activity, you will use graphs to investigate motion. The graphs will represent your own motion and will be drawn by the computer as you move.

Equipment:

motion detector (sonic ranging device) meter stick LabQuest OR LabPro & computer with LoggerPro software

Discussion:

Graphs can be used to represent motion. For example, if you track the position of an object as time goes by, you can make a plot of position vs. time. In this activity, the sonic ranger will track your position and the computer will draw a position vs. time graph of your motion. The motion detector sends out a pulse of high frequency sound and



then listens for the echo. By keeping track of how much time goes by between each pulse and corresponding echo, the detector determines how far you are from it. (Bats use this technique to navigate in the dark.) By continually sending pulses and listening for echoes, the motion detector tracks your position over a period of time. This information is fed to the computer or LabQuest, and the software generates position vs. time and velocity vs time graphs.

Procedure - *LABQUEST*

- 1. Find an open area at least 4 m long in front of a wall.
- If your Motion Detector has a switch, set it to Normal. Connect the Motion Detector to DIG 1 of LabQuest and choose New from the File menu. If you have an older sensor that does not auto-ID, manually set up the sensor.
- 3. On the Meter screen, tap Length, then change the data-collection length to 10 seconds. Select OK.
- 4. Open the hinge on the Motion Detector. When you collect data, hold the Motion Detector so the round, metal detector is always pointed directly at the wall. Sometimes you will have to walk backwards.
- 5. Monitor the position readings. Move back and forth and confirm that the values make sense. Go to Graph ► Graph Options and change the values for Graph 1 Y-axis to bottom:0 and top:4 and for Graph 2 Y-axis to bottom:-2 and top:2.
- 6. Start data collection with the arrow button below the screen. Note how close and how far you can get to and from the wall before the readings become unreliable.
- 7. Follow instructions under Multiple Representations of Motion.





1. Connect the Motion Detector to the DIG/SONIC 1 channel of LabPro. If the Motion Detector has a sensitivity switch, set it to Normal. Connect your LabPro to the computer



- 2. Place the Motion Detector so that it points toward an open space at least 4 m long.
- 3. Open LoggerPro3. Go to Experiment>Connect Interface>LabPro and choose COM1, COM2 or USB depending on how the LabPro is connected to the computer. You will know if you chose the correct option because the collect arrow button will be green. Change the scale on the position axis to from 0 to 4 and on the velocity axis from -2 to 2. You can do this by clicking on the bottom and top numbers on each axis and typing in the new values.
- 4. Have your lab partner click ► collect. Walk slowly towards and away from the Motion Detector when you hear it begin to click. Note how close and how far you can get to and from the motion detector before the readings become unreliable.
- 5. Follow instructions under Multiple Representations of Motion.



Multiple Representations of Motion

Do the following for each of the situations below:

- a. Move, relative to the motion detector, so that you produce a position vs. time graph which closely approximates the graph shown.
- b. In the space provided, describe how you must move in order to produce the position vs. time graph shown in the space to the right of the velocity vs. time graph. Be sure to include each of the following in your description: starting position, direction moved, type of motion, relative speed.
- c. On the velocity vs. time axes, sketch the velocity vs. time graph which corresponds to the position vs. time graph shown.
- d. In the space provided, sketch the motion map that corresponds to the motion described in the position vs. time graph.





5.



Part II Position vs. Time Graph Matching

EXTENSIONS - LABQUEST

Position vs. Time Graph Matching

- 1. Choose Motion Match ► New Position Match from the Analyze menu to set up LabQuest for graph matching. A target graph will be displayed for you to match.
- 2. Write down how you would walk to reproduce the target graph. Sketch a copy of the graph.

- 3. To test your prediction, choose a starting position. Start data collection, then walk in such a way that the graph of your motion matches the target graph on the screen.
- 4. If you were not successful, start data collection again when you are ready to begin walking. Repeat this process until your motion closely matches the graph on the screen. Sketch the graph with your best attempt in a different color on the graph above.

Velocity vs. Time Graph Matching

- LabQuest can also generate random target velocity graphs for you to match. Choose Motion Match
 ▶ New Velocity Match from the Analyze menu to view a velocity target graph.
- 6. Write down how you would walk to produce this target graph. Sketch a copy of the graph.

- 7. To test your prediction, choose a starting position and stand at that point. Have your partner start data collection, then walk in such a way that the graph of your motion matches the target graph on the screen. It will be more difficult to match the velocity graph than it was for the position graph.
- 8. If you were not successful, have your partner start data collection when you are ready to start walking. Repeat this process until your motion closely matches the graph on the screen. Sketch the graph with your best attempt in a different color on the graph above.

EXTENSIONS - LABPRO

Position vs. Time Graph Matching

- 1. Open the experiment file "01b Graph Matching." in the folder *Physics with Vernier*. A position *vs.* time graph will appear.
- 2. Describe how you would walk to produce this target graph.
- 3. To test your prediction, choose a starting position and stand at that point. Have your partner start data collection by clicking **collect**. When you hear the Motion Detector begin to click, walk in such a way that the graph of your motion matches the target graph on the computer screen.
- 4. If you were not successful, repeat the process until your motion closely matches the graph on the screen. Print the graph with your best attempt.

Velocity vs. Time Graph Matching

- 5. Open the experiment file "01d Graph Matching." A velocity vs. time graph will appear.
- 6. Describe how you would walk to produce this target graph.

- 7. To test your prediction, choose a starting position and stand at that point. Have your partner start by clicking **▶** collect. When you hear the Motion Detector begin to click, walk in such a way that the graph of your motion matches the target graph on the screen. It will be more difficult to match the velocity graph than it was for the position graph.
- 8. If you were not successful, repeat the process until your motion closely matches the graph on the screen. Print the graph with your best attempt.