

# LAB 1

## Motion Diagrams

### OBJECTIVES

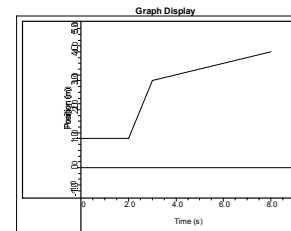
- (1) Use the Motion Sensor to measure and plot your position and velocity as you move in a straight line at different speeds.
- (2) Understand the concept of position, velocity, and acceleration.

### EQUIPMENT

DataStudio, motion sensor, support rod, moving object (you)

### BACKGROUND

When describing the motion of an object, knowing where it is relative to a reference point, how fast and in what direction it is moving, and how it is accelerating (changing its rate of motion) is essential. A sonar ranging device such as the PASCO Motion Sensor uses pulses of ultrasound that reflect from an object to determine the position of the object. As the object moves, the change in its position is measured many times each second. The change in position from moment to moment is expressed as a velocity (meters per second). The change in velocity from moment to moment is expressed as an acceleration (meters per second per second). The position of an object at a particular time can be plotted on a graph. You can also graph the velocity and acceleration of the object versus time. A graph is a mathematical picture of the motion of an object. For this reason, it is important to understand how to interpret a graph of position, velocity, or acceleration versus time. In this activity you will plot a graph of position in real-time, that is, as the motion is happening.



### PROCEDURE

#### Part 1: Position vs. Time

For this activity, *you* will be the object in motion. Use the Motion Sensor to measure your position as you move in a straight line at different speeds. Use *DataStudio* to plot your motion on a graph of position and time. The challenge is to move in such a way that a plot of your motion on the same graph will “match” the line that is already there. This activity is easier to do if you have a partner to run the computer while you move. Connect the Motion Sensor to DataStudio.

- (1) Open the document titled **position game easy.ds**. The document has a Graph display of Position versus Time. The Graph shows Position and Time values that were entered into the Graph.
- (2) Mount the Motion Sensor on a support rod so that it is aimed at your midsection when you are standing in front of the sensor. Make sure that you can move at least 2 meters away from the Motion Sensor. Position the computer monitor so you can see the screen while you move away from the Motion Sensor.
- (3) Study the plot of Position versus Time. Sketch the plot and describe in words the motion represented by the graph (i.e. standing still for 3 seconds, moving forward at 1.5 m/s for 2 seconds, ...).
- (4) When you are ready, stand in front of the Motion Sensor. When everything is ready, start recording data. There is a three-second countdown before data recording begins. The “cursor” on the vertical axis of the Graph will move up and down as you move forward and backward relative to the sensor. Use the feedback from ‘cursor’ to find your best starting position.
- (5) Watch the plot of your motion on the Graph and try to move so the plot of your motion matches the Position versus Time plot already there. Determine how well your plot of motion fits the plot that was already in the Graph by examining the “Match Data” calculation. Repeat the data recording process a second time. Try to improve the match between the plot of your motion and the plot that is already on the Graph.
- (6) Have each member of your group try and reproduce the graph using the motion detector. See if each group member can get a “Match Data” score of less than 3.0.
- (7) Open the document titled **position game hard.ds**. Sketch the plot and describe the motion represented by the graph in words (i.e. standing still for 3 seconds, moving backward at 0.70 m/s for 1.5 seconds, ...).
- (8) Have each member of your group try and reproduce the graph using the motion detector. **Any group member that receives a score of less than 5.0 gets a prize.**

## Part 2: Velocity vs. Time

For this activity, you will be using the Motion Sensor to measure your velocity rather than your position. Again, the challenge is to move in such a way that a plot of your motion on the same graph will “match” the line that is already there. You will find that matching the velocity graph is significantly more difficult than matching the position graph.

- (1) Open the document titled **velocity game easy.ds**.
- (2) Study the plot of Velocity versus Time. When everything is ready, start recording data. Data recording will begin almost immediately. Watch the plot of your motion on the Graph, and try to move so that the plot of your motion matches the Velocity versus Time plot that is already there.
- (3) Repeat the data recording process a second time to try and improve the match between the plot of your motion and the plot that is already on the Graph. Have each member of your group try and reproduce the graph using the motion detector
- (4) Open the document titled **velocity game hard.ds**.
- (5) Study the plot of Velocity versus Time. When everything is ready, start recording data. Have each member of your group try and reproduce the graph using the motion detector. **The person who gets the lowest score in the class receives a prize.**