**Velocity Test:**

**Interpreting Velocity Graphs**

When you walk, ride a bike, or travel in a car, you are often interested in the distance traveled, the time it took, and the speed or velocity of your motion. In this activity, you will learn more about how these four quantities are related.

Speed and velocity are often confused since the terms are sometimes used interchangeably, but they are not the same thing. So what is the difference? Speed is how far you have gone, divided by the time it took to move. In other words, speed tells how fast you are traveling, but without regard to direction. Since the distance you have traveled is always positive, speed is always positive. On the other hand, velocity is the rate of change of position. Position is the directed distance from a chosen starting point, or origin. If we consider only motion on the positive side of the origin, motion away from the origin is a positive change in position, while motion toward the origin is a negative change in position. Velocity can, therefore, be either positive or negative depending upon your direction of motion. The data from a Motion Detector is a directed distance, so it can easily be used to calculate velocity.

Velocity is defined as the change in position divided by the change in time, or

Here, d1 and d2 are your positions at two particular times and This definition should look familiar, for it has exactly the same form as that of slope for a y versus x graph, or

If you look at a plot of distance from the detector, which is position as a function of time, the velocity is the slope of that graph. For simple distance graphs you can find the slope of a segment of the graph to find the corresponding velocity during that time interval. In this activity, you will calculate a few velocities from a distance graph and compare them to the velocity graph produced by DataQuest.

**OBJECTIVES**

• Record distance versus time data for a simple motion of a walker.

• Analyze the distance versus time data to sketch the form of a corresponding velocity versus time graph.

• Compare this velocity graph with the velocity graph determined by DataQuest.

**MATERIALS**

TI-Nspire handheld or
 computer and TI-Nspire software

CBR 2 or Go!Motion or

 Motion Detector and data-collection interface



**PROCEDURE**

1. If your Motion Detector has a switch, set it to Normal. Connect the Motion Detector to the data- collection interface. Connect the interface to the TI-Nspire handheld or computer. (If you are using a CBR 2 or Go!Motion, you do not need a data-collection interface.)

2. Place the Motion Detector on the edge of a table about waist level, pointing into an open area. You will need at least 2 meters unobstructed space to walk in front of the detector.

3. Set up DataQuest for data collection. a. Choose New Experiment from the Experiment menu. For this experiment, the default data-collection parameters for a Motion Detector will be used. (Rate: 20 samples per second; Duration: 5 seconds). The number of points collected should be 101. b. Click the Graph View tab ( ). Choose Show Graph ► Graph 1 from the Graph menu. You should now see only the graph of position versus time.

4. For this activity you need a position versus time graph that shows both positive and negative slope, but you do not want it to be too complicated. Stand about 1 m in front of the Motion Detector. After you hear the clicking start, stand still for about a second. Then walk slowly away for about two seconds at a uniform rate, and then walk toward the detector for the remaining time. Do not get any closer than 15 cm from the detector.

When you are ready, start data collection ( ) and walk as described above. Data collection will run for five seconds. Velocity Test Real-World Math with Vernier 12 - 3

5. When data collection is complete, a graph of distance versus time will be displayed. Examine the graph. This graph should start with a nearly horizontal region, followed by a fairly linear increase, followed by a fairly linear decrease. Check with your teacher if you are not sure whether you need to repeat the data collection. To repeat data collection, repeat to Step 4.

**DATA TABLE**

|  |  |  |
| --- | --- | --- |
|  | t | d |
| point 1 |  |  |
| point 2 |  |  |
| point 3 |  |  |
| point 4 |  |  |

|  |  |
| --- | --- |
|  | slope |
| segment 1 |  |
| segment 2 |  |
| segment 3 |  |

**ANALYSIS**

1. Click any data point and use ► and ◄ to examine the data. Determine the time interval when the velocity is positive. In other words, when is the slope of the position vs. time graph positive? Record the starting and ending times in Analysis Question 1, and then answer Analysis Questions 2 and 3.

2. There should be three roughly linear segments:
• The first segment runs from t1 = 0 s to a later time that we will call t2.
• The next segment starts at t2 and runs to time t3 when you changed direction.
• The last segment runs from t3 to the end of the data collection, which we will call t4.
Add Data Markers to easily identify these four points on the graph and in the table.

a. Click any data point and use ► and ◄ to highlight the left most point to designate t1.

b. Move your cursor over the details box and launch the contextual menu (handheld – /b; computer – right-click).

c. Choose Data Marker ► Add Data Marker.

d. Enter t1 as the Marker Text and select OK. e. Click any data point and use ► and ◄ to highlight the point you want to designate as t2. f. Repeat the steps above to add Data Markers for t2-t4. Record the x and y coordinates of the four points in your data table. Answer Analysis Questions 4–10.

**ANALYSIS QUESTIONS**

1. Record the starting and ending times when the velocity is positive.

2. Identify all intervals where the velocity is negative. Explain how you know the velocity values are negative for these intervals.

3. What portions of the graph represent a velocity of zero? Explain your answer.

4. Make a sketch of your position vs. time graph using just the three segments you’ve extracted from your raw data.

5. Calculate the slope of the each of the three segments and enter them in the data table. Note that the slope is just the velocity during the corresponding time interval. What are the units of the slope?

6. Now use the slopes of the three segments to sketch a velocity vs. time graph. Since each slope is also a velocity value for that time interval, your velocity graph will consist of three horizontal lines at various heights. Velocity Test Real-World Math with Vernier 12 - 5

7. You can view the velocity graph by choosing Select Y-axis Columns ► run1.Velocity from the Graph menu. How does the DataQuest graph compare to yours?

8. Why might the DataQuest graph and your graph be different? Hint: Does DataQuest use just three segments to find slopes?

9. Complete the following table showing characteristics of a velocity graph for specific kind of motion.

|  |  |
| --- | --- |
| Actual Motion | Velocity Graph Characteristic |
| Person moves toward the detector |  |
| Person stands still |  |
| Person moves away from the detector |  |