Investigation 2: Velocity-Time Graphs of Your Motion

To find out
The connection between velocity and your actual motion
How your motion looks as a velocity-time graph

Materials
MacMotion software (*Motion* for MS-DOS)
motion detector
Universal Laboratory Interface (ULI)
number line on floor in meters (optional)

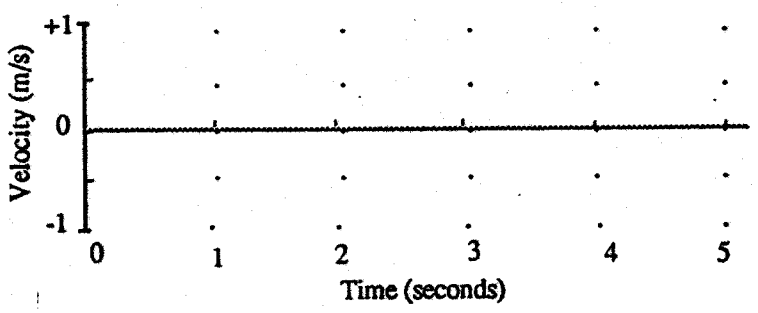
Introduction
You have already plotted your distance (position) from the motion detector as a function of time. You can also plot how fast you are moving. How fast you move is your speed . It is the rate of change of distance with respect to time. *Velocity* takes into account your speed and the direction you are moving. When you measure motion along a line, velocity can be positive or negative.

Activity 1 **Making Velocity Graphs**

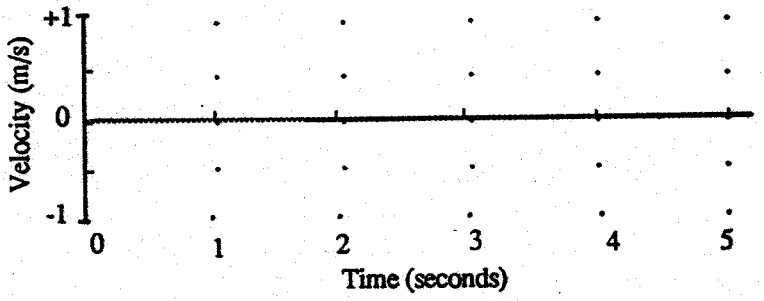
1. Set up to graph velocity. Double click anywhere on the distance graph to display the dialog box. Move the mouse pointer to the **Distance** label, hold down the button and select **Velocity**. Set the **Velocity** axis from **-1** to **1** m/sec. Also change the **Time** axis to read **0** to **5** sec.
2. Graph your velocity for different walking speeds and directions.
   a. Make a velocity graph by walking *away* from the detector *slowly and steadily* . Try again until you get a graph you're satisfied with.

      You may want to change the velocity scale so that the graph fills more of the screen and is clearer. To do this, double click anywhere on the graph and change the velocity range.

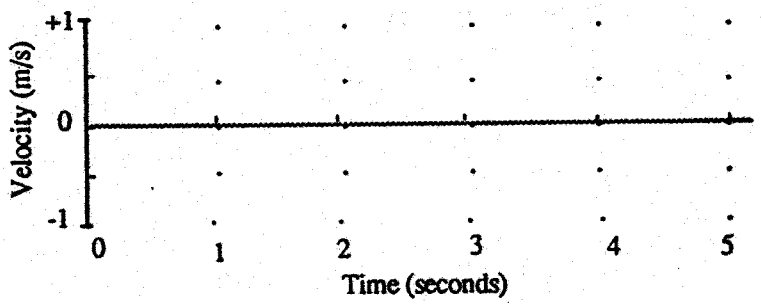
      Sketch your result below. (Just draw *smooth* patterns; leave out smaller bumps that are mostly due to your steps.)



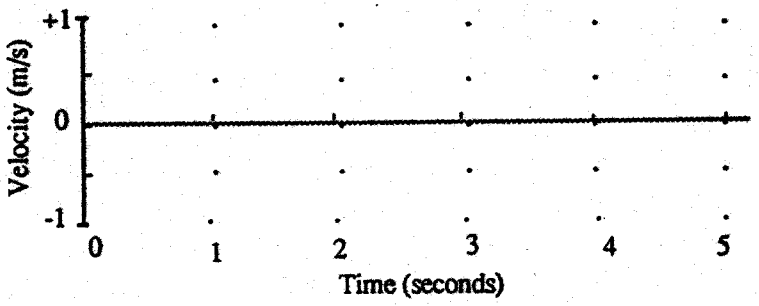
b. Make a velocity graph, walking *away* from the detector *medium fast and steadily*. Sketch your graph.



c. Make a velocity graph, walking *toward* the detector *slowly and steadily*. Sketch your graph.



d. Make a velocity graph, walking *toward* the detector *medium fast and steadily*. Sketch your graph.



Questions

What is the most important difference between the graph made by slowly walking away from the detector and the one made by walking away more quickly? (Q1)

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How are the velocity-time graphs different for motion away and motion toward the detector? (Q2)

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_____

3. Predict a velocity graph for a more complicated motion and check your prediction.

   a. Each person draw below, using a *dotted line,* your *prediction* of the velocity graph produced if you—

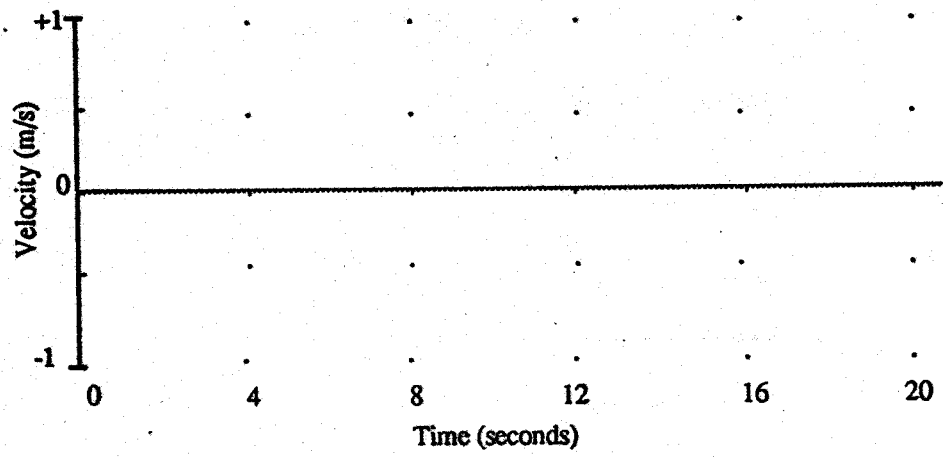
      • walk away from the detector slowly and steadily for 10 seconds

      • stop for 4 seconds

      • walk toward the detector steadily about twice as fast as before

   b. Compare predictions and see if you can all agree. Use a solid line to draw in your group prediction.

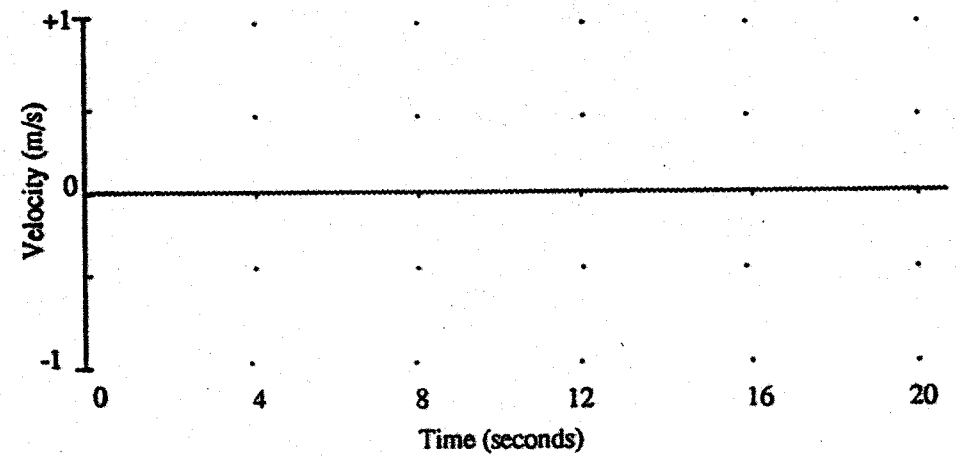
Prediction



4. Do the experiment. (Be sure to adjust the time scale to 20 seconds. To do this double click anywhere on the graph and change the time scale.) Repeat your motion until you think it matches the description.

   Draw the best graph on the axes below. Be sure the 4-second stop shows clearly.

Final Result



Comment

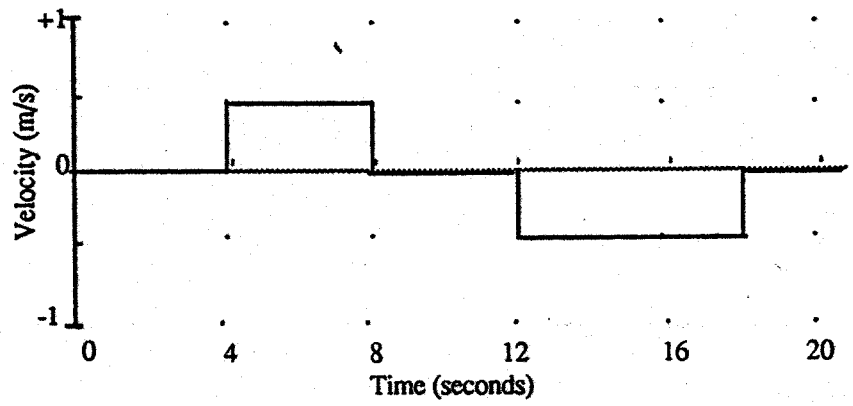
How fast you move is your speed, the rate of change of distance with respect to time. Velocity implies both speed and *direction.* As you have seen, for motion along a line (the positve x axis) the sign (+ or -) of the velocity indicates the direction. If you move away from the detector (origin), your velocity is positive, and if you move toward the detector, your velocity is negative.

The faster you move *away* from the origin, the larger positive number your velocity is. The faster you move *toward* the origin, the "larger" negative number your velocity is. That is -4 m/s is twice as fast as -2 m/s and both motions are toward the origin.

Activity 2 **Matching a Velocity Graph**

In this activity, you will move to match a velocity graph shown on the computer screen.

1. Display the velocity graph on the screen. Pull down the File Menu and select **Open.** Then double click on **Velocity Match.** The velocity graph below will appear on the screen.



2. Move so as to imitate this graph. You may try a number of times. Work as a team and plan your movements. Get the times right. Get the velocities right. Each person should take a turn.

   Draw in your group's best match on the axes above.

Questions

Describe how you moved to match each part of the graph. (Q3)

Is it possible for an object to move so that it produces an absolutely vertical line on a velocity time graph? Explain. (Q4)