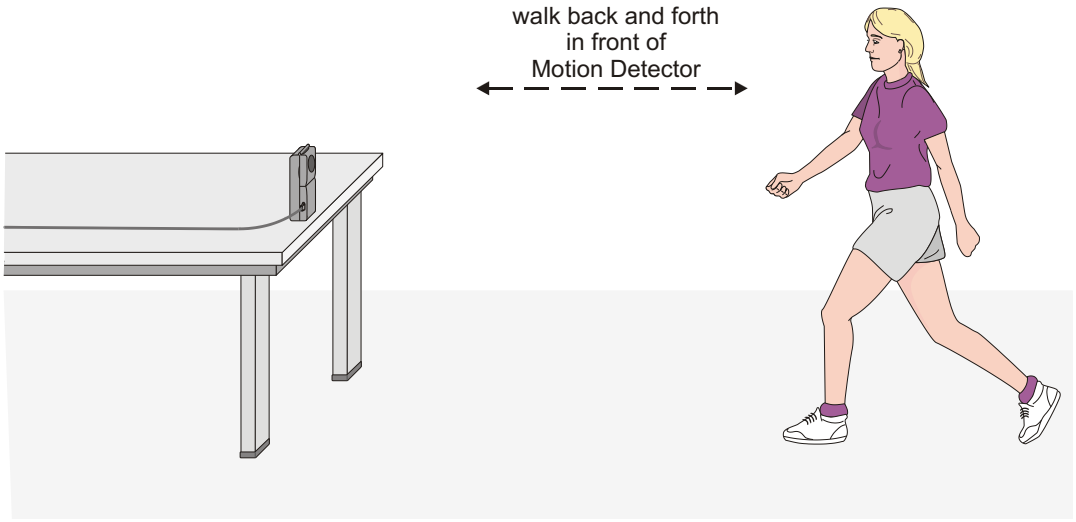
Experiment
1

Graph Matching

One of the most effective methods of describing motion is to plot graphs of distance, velocity, and acceleration *vs*. time. From such a graphical representation, it is possible to determine in what direction an object is going, how fast it is moving, how far it traveled, and whether it is speeding up or slowing down. In this experiment, you will use a Motion Detector to determine this information by plotting a real time graph of *your* motion as you move across the classroom.

The Motion Detector measures the time it takes for a high frequency sound pulse to travel from the detector to an object and back. Using this round-trip time and the speed of sound, you can determine the distance to the object; that is, its position. Logger *Pro* will perform this calculation for you. It can then use the change in position to calculate the object's velocity and acceleration. All of this information can be displayed either as a table or a graph. A qualitative analysis of the graphs of your motion will help you develop an understanding of the concepts of kinematics.



OBJECTIVES

- Analyze the motion of a student walking across the room.
- Predict, sketch, and test distance *vs*. time kinematics graphs.
- Predict, sketch, and test velocity *vs*. time kinematics graphs.

MATERIALS

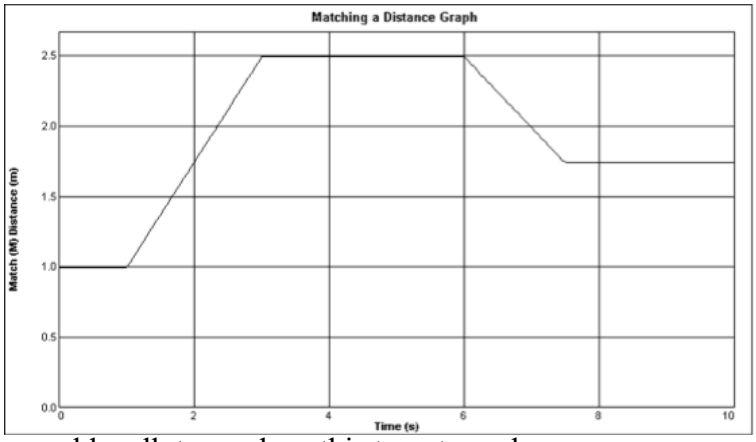
Power Macintosh or Windows PC
LabPro or Universal Lab Interface
Logger *Pro*
Vernier Motion Detector

PRELIMINARY QUESTIONS

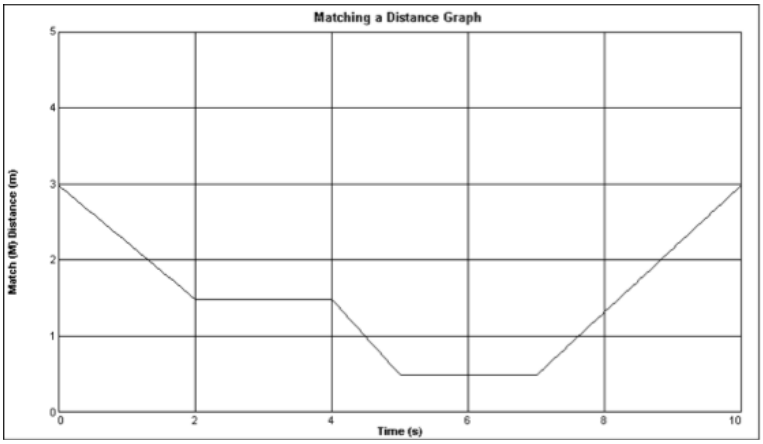
1. Use a coordinate system with the origin at far left and positive distances increasing to the right. Sketch the distance *vs*. time graph for each of the following situations:
   - An object at rest
   - An object moving in the positive direction with a constant speed
   - An object moving in the negative direction with a constant speed
   - An object that is accelerating in the positive direction, starting from rest

Part I Distance *vs*. Time Graph Matching

7. Open the experiment file Exp 01b Distance Match One. The distance *vs*. time graph shown will appear.

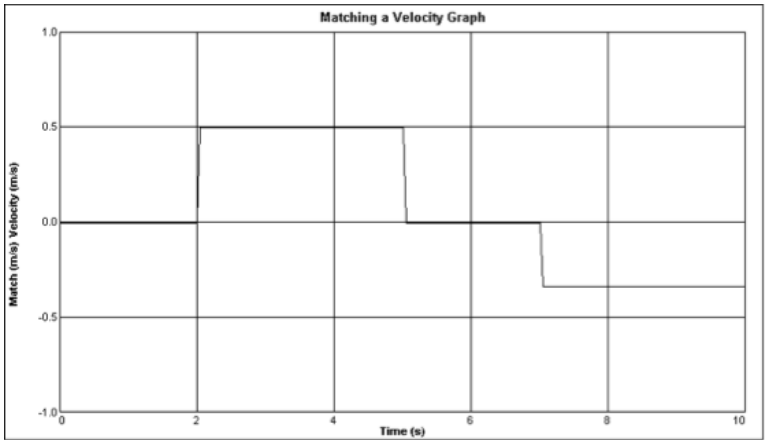


8. Describe how you would walk to produce this target graph.
9. To test your prediction, choose a starting position and stand at that point. Start data collection by clicking Collect. When you hear the Motion Detector begin to click, walk in such a way that the graph of your motion matches the target graph on the computer screen.
10. If you were not successful, repeat the process until your motion closely matches the graph on the screen. If a printer is attached, print the graph with your best attempt.
11. Open the experiment file Exp 01c Distance Match Two and repeat Steps 8 – 10, using a new target graph.



Part II Velocity *vs*. Time Graph Matching

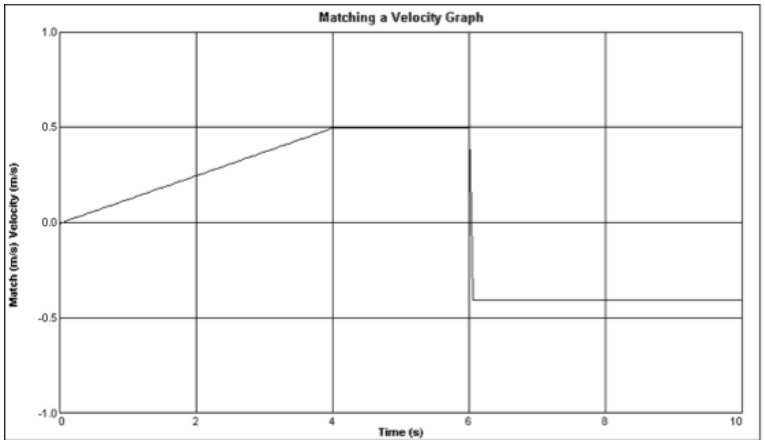
13. Open the experiment file Exp 01d Velocity Match One. You will see the following velocity *vs*. time graph.



14. Describe how you would walk to produce this target graph.

15. To test your prediction, choose a starting position and stand at that point. Start Logger *Pro* 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 distance graph.

16. Open the experiment file Exp 01e Velocity Match Two. Repeat Steps 14 – 15 to match this graph.



ANALYSIS

Part I Distance *vs*. Time Graph Matching

1. Describe how you walked for each of the graphs that you matched.

2. Explain the significance of the slope of a distance *vs*. time graph. Include a discussion of positive and negative slope.

3. What type of motion is occurring when the slope of a distance *vs*. time graph is zero?

4. What type of motion is occurring when the slope of a distance *vs*. time graph is constant?

5. What type of motion is occurring when the slope of a distance *vs*. time graph is changing? Test your answer to this question using the Motion Detector.

Part II Velocity *vs*. Time Graph Matching

7. Describe how you walked for each of the graphs that you matched.

8. Using the velocity *vs*. time graphs, sketch the distance *vs*. time graph for each of the graphs that you matched. In Logger *Pro*, switch to a distance *vs*. time graph to check your answer. Do this by clicking on the y-axis label and unchecking velocity; then check Distance. Click 

to see the distance graph.

9. What type of motion is occurring when the slope of a velocity *vs*. time graph is zero?

10. What type of motion is occurring when the slope of a velocity *vs*. time graph is not zero? Test your answer using the Motion Detector.