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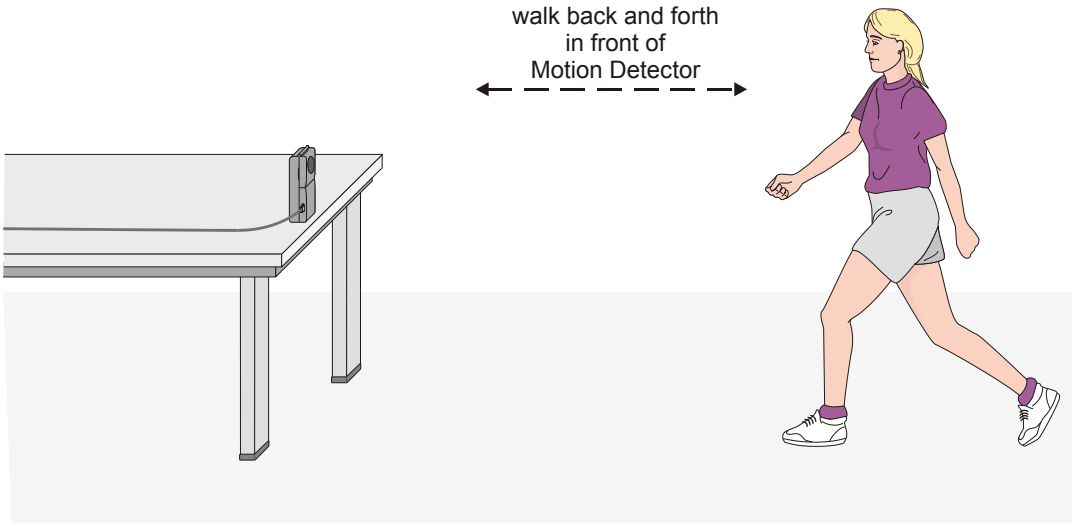
Graph Matching 2012

One of the most effective methods of describing motion is to plot graphs of position, 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 position of the object. 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 position *vs*. time kinematics graphs.
- Predict, sketch, and test velocity *vs*. time kinematics graphs.

PRELIMINARY QUESTIONS

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

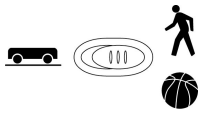
2. Sketch the velocity *vs*. time graph for each of the situations described above.

A) B)

C) D)

PROCEDURE

Part I Preliminary Experiments



1. Connect the Motion Detector to the DIG/SONIC 1 channel of the interface. If the Motion Detector has a sensitivity switch, set it to Normal.
2. Place the Motion Detector so that it points toward an open space at least 4 m long. Use short strips of masking tape on the floor to mark the 1 m, 2 m, 3 m, and 4 m positions from the Motion Detector.
3. Open the file "01a Graph Matching" from the *Physics with Vernier* folder.
4. Using Logger *Pro*, produce a graph of your motion when you walk away from the detector with constant velocity. To do this, stand about 1 m from the Motion Detector and have your lab partner click Collect. Walk slowly away from the Motion Detector when you hear it begin to click.
5. Sketch what the position *vs.* time graph will look like if you walk faster. (Sketch Below)

Check your prediction with the Motion Detector. How did you do?

6. Try to match the shape of the position *vs*. time graphs that you sketched in the Preliminary Questions section by walking in front of the Motion Detector.

Part II Position *vs*. Time Graph Matching

7. Open the experiment file "01b Graph Matching." A position *vs*. time graph 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. (One graph per lab member. Each member must perform the experiment.)
11. Open the experiment file "01c Graph Matching" and repeat Steps 8–10, using a new target graph.

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

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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.

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. (One graph per lab member. Each member must perform the experiment.)

ANALYSIS

Part II Position *vs*. Time Graph Matching

1. Describe how you walked for each of the graphs that you matched. (You did this above.)

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

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

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

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

6. Return to the procedure and complete Part III.

Part III Velocity *vs*. Time Graph Matching

13. Open the experiment file "01d Graph Matching." A velocity *vs*. time graph will appear.
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 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.
16. Open the experiment file "01e Graph Matching." Repeat Steps 14–15 to match this graph.
17. Remove the masking tape strips from the floor.

Part III Velocity *vs*. Time Graph Matching

7. Describe how you walked for each of the graphs that you matched. (You did this above.)
8. What type of motion is occurring when the slope of a velocity *vs*. time graph is zero?

9. 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.