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Experiment
33

Graphing Your Motion

Graphs made using a Motion Detector can be used to study motion. In this experiment, you will use a Motion Detector to make graphs of your own motion.

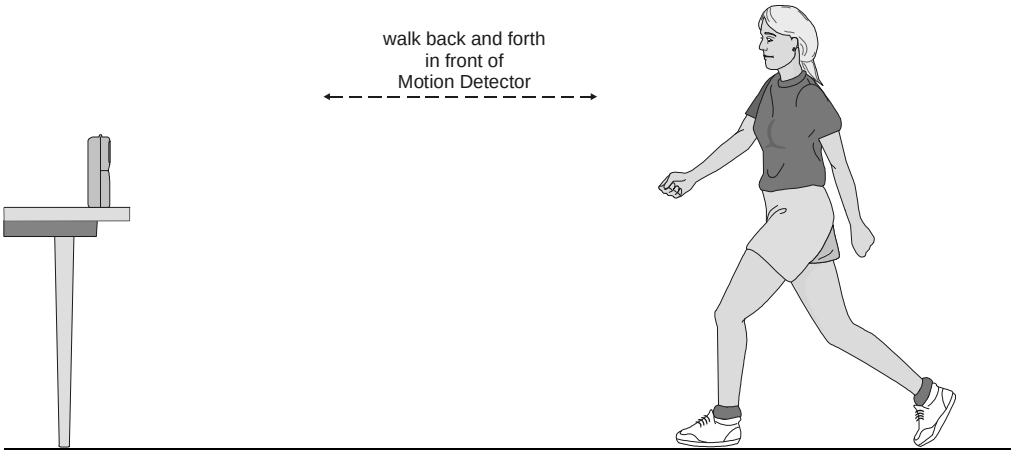
OBJECTIVES

In this experiment, you will

- Use a Motion Detector to measure position, velocity, and acceleration.
- Use a computer to produce graphs of your motion.
- Analyze the graphs you produce.
- Match position *vs*. time and velocity *vs*. time graphs.

MATERIALS

computer
Vernier computer interface
Motion Detector
masking tape
meter stick

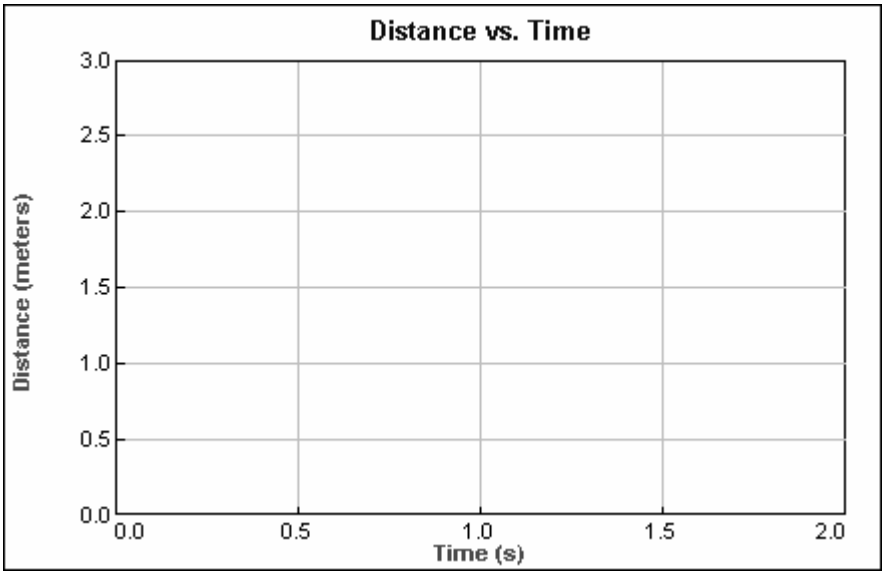


PROCEDURE

Part A Position

1. Fasten a Vernier Motion Detector to a tabletop facing an aisle. Connect the Motion Detector. If your Motion Detector has a sensitivity switch, set it to Normal.
2. 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. Launch the Vernier data-collection program and open the file "33a Graphing Motion" from the *Middle School Science with Computers* folder.

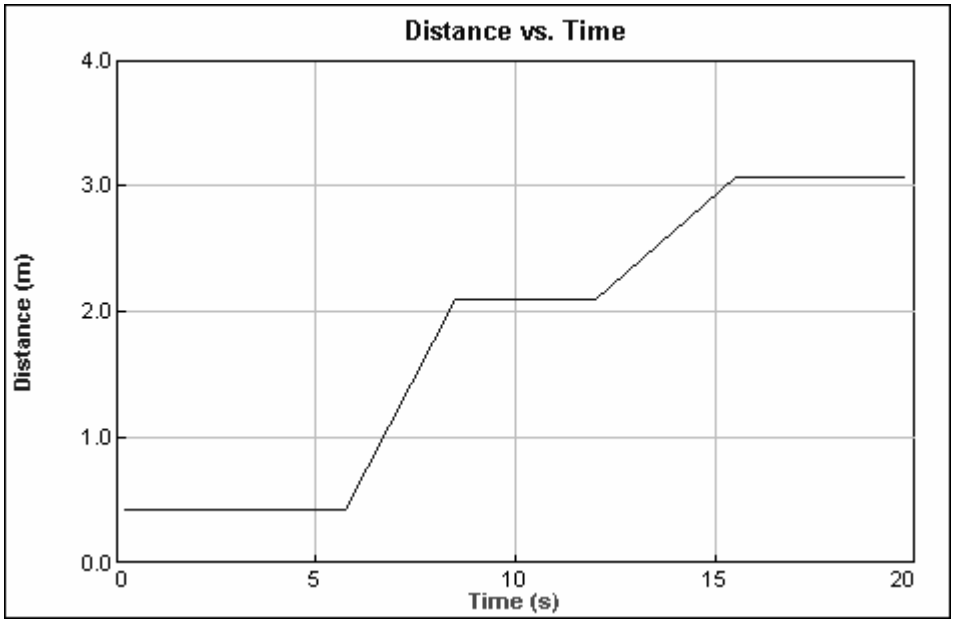


4. Stand at the 1 m position facing the Motion Detector and the computer screen. Have your partner click Collect. Slowly walk backwards away from the Motion Detector and watch the screen.

5. Choose Store Latest Run from the Experiment menu. Repeat Step 4, moving faster this time.

6. Sketch your results on the above graph.

7. Open the file "33b Graph Matching." You should see the following position *vs.* time graph.



8. Try to match the line by moving toward or away from the Motion Detector. Sketch your results on the graph above. Have everyone in your group try to match the line.

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PROCESSING THE DATA (Part A)

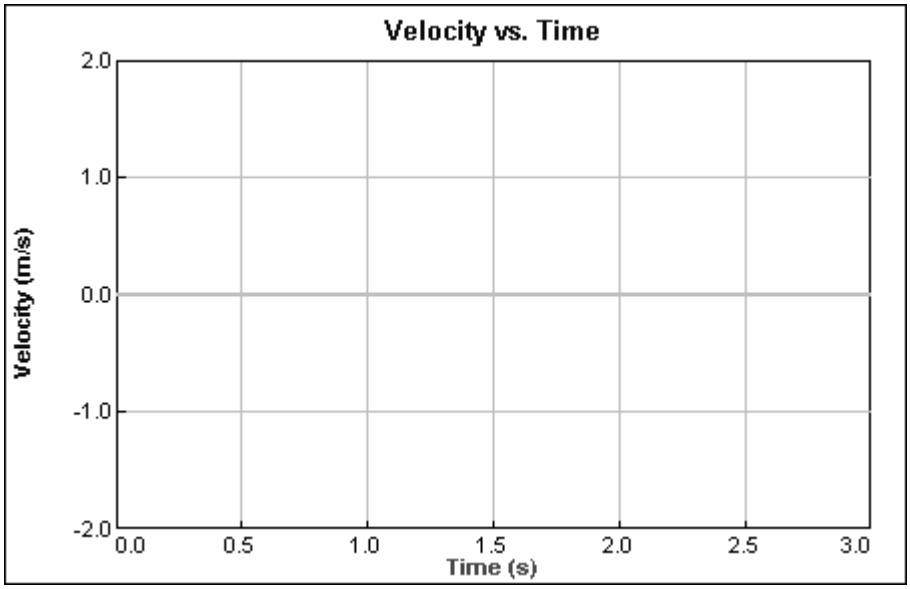
1. Describe the difference between the two lines on your graph made in Steps 4 and 5. Explain why the lines are different.

2. How would the graph change if you walked toward the Motion Detector rather than away from it? Test your answer.

3. What did you have to do to match the graph you were given in Step 7?

Part B Velocity

9. Open the file "33c Graphing Motion."

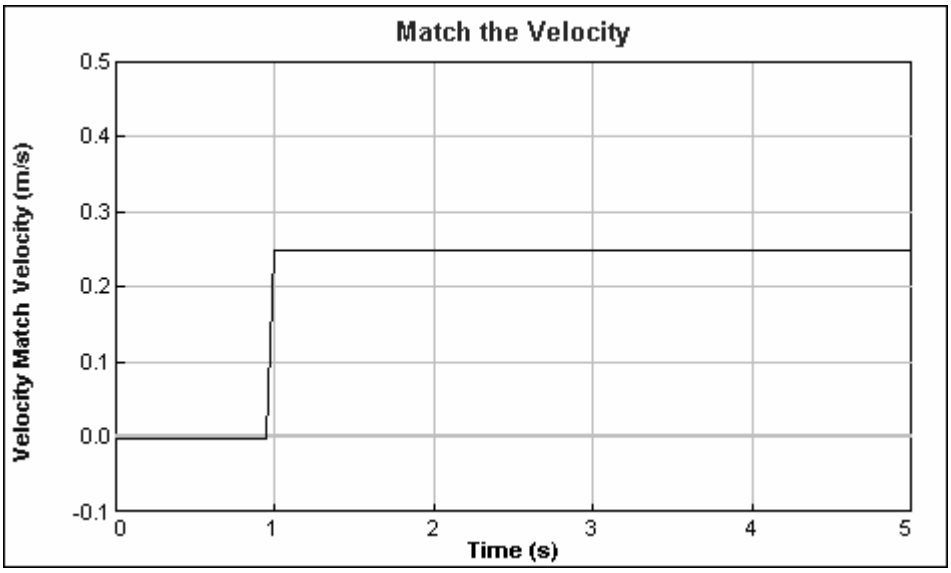


10. Stand at the 1 m position facing the Motion Detector and the computer screen. Have your partner click Collect, then slowly walk backwards away from the Motion Detector.

11. Choose Store Latest Run on the Experiment menu. Repeat Step 10, moving faster this time.

12. Sketch your results on the graph above.

13. Open the file "33d Graphing Motion." You should see the following velocity *vs*. time graph.



14. Try to match the line by moving toward or away from the Motion Detector. Sketch your results on the above graph. Have everyone in your group try to match the line.

PROCESSING THE DATA (Part B)

4. Describe the difference between the two lines on the graph made in Steps 10 and 11. Explain why the lines are different.

5. What is the definition of velocity?

6. What did you have to do to match the graph you were given in Step 13? How well does your graph match the given graph?

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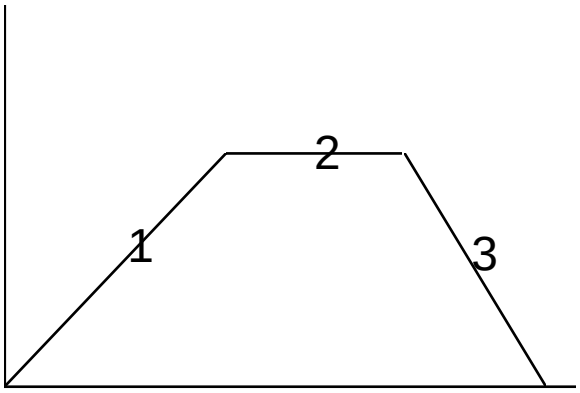
7. Describe the motion needed to make this graph:

   If it is a position *vs*. time graph:

   If it is a velocity *vs*. time graph:



   You can check your answers using a Motion Detector.

Part C Acceleration

15. Open the file "33e Graphing Motion."

16. Stand at the 1 m position, this time with your back to the Motion Detector. Have your partner click Collect. Pause for about one second and then walk rapidly to the 3 m mark and stop. Say "stop" when you have stopped. As you say "stop," your partner should click Stop. Print or sketch your results.

PROCESSING THE DATA (Part C)

8. How does the acceleration *vs*. time graph differ from the other two graphs?

9. On your velocity *vs*. time graph, label the acceleration and deceleration portions.

10. On your acceleration *vs*. time graph, label the acceleration and deceleration portions.

11. What is acceleration?

EXTENSIONS

1. Create a graph-making challenge. Open the file "33f Graphing Motion", which contains a blank position *vs.* time graph. Use Draw Prediction from the Analyze menu to draw a position *vs*. time graph and challenge another student in the class to match your graph. Have the other student challenge you in the same way.

2. Use the graph on Page 2 of the file "33f Graphing Motion" and the Draw Prediction feature to create a velocity *vs*. time challenge in a similar manner.

3. Create a position *vs*. time graph by walking in front of the Motion Detector. Store the graph by choosing Store Latest Run from the Experiment menu. Have another student match your run.

4. Create a velocity *vs*. time graph by walking in front of the Motion Detector. Store the graph by choosing Store Latest Run from the Experiment menu. Have another student match your run.

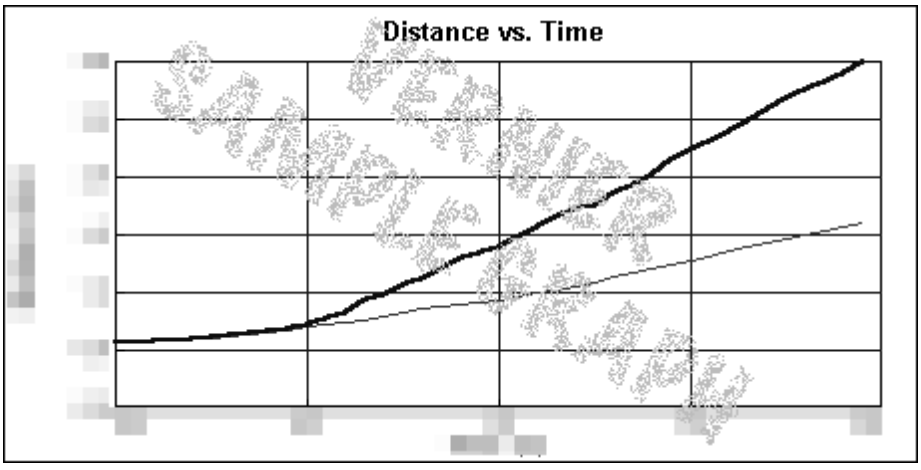
TEACHER INFORMATION

Graphing Your Motion

1. A Vernier LabPro and Motion Detector or a Go! Motion is needed to perform this experiment.
2. This experiment may be the first time your students use the Motion Detector. A little coaching on its use now will save time later in the year as the Motion Detector is used in other experiments. Here are some hints for effective use of the Motion Detector.
   - In using the Motion Detector, it is important to realize that the ultra sound is emitted in a cone about 30° wide. Anything within the cone of ultrasound can cause a reflection and possibly an accidental measurement. A common problem in using Motion Detectors is getting unintentional reflections from a desk, chair, or computer in the room.
   - Often unintended reflections can be minimized by tilting the Motion Detector slightly.
   - If you begin with a velocity or acceleration graph and obtain a confusing display, switch back to a position graph to see if it makes sense. If not, the Motion Detector may not be properly targeting the target.
   - The Motion Detector has a switch under the pivoting head. Set the switch to Normal mode.
   - In Normal mode, the Motion Detector does not properly detect objects closer than 0.15 m. The maximum range is about 6 m, but stray objects in the wide detection cone can be problematic at this position.
   - Sometimes a target may not supply a strong reflection of the ultrasound. For example, if the target is a person wearing a bulky sweater, the resulting graph may be inconsistent.
   - If the velocity and acceleration graphs are noisy, try to increase the strength of the ultrasonic reflection from the target by increasing the target's area.
3. You may want to have your students hold a large book in front of them as they walk in front of the Motion Detector. This will produce better graphs because it smoothes out the motion.
4. The Part C graph is the only graph that should be printed in this experiment.

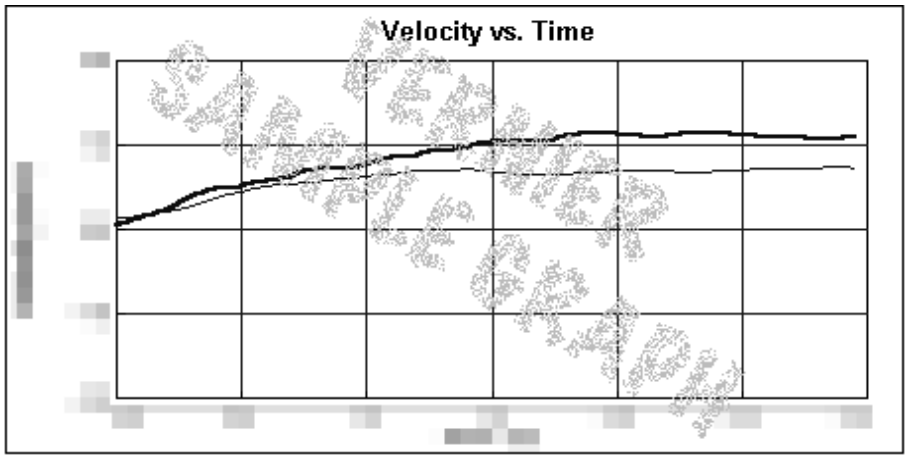
ANSWERS TO QUESTIONS

Part A Position



Answers have been removed from the online versions of Vernier curriculum material in order to prevent inappropriate student use. Graphs and data tables have also been obscured. Full answers and sample data are available in the print versions of these labs.

Part B Velocity



Part C Acceleration