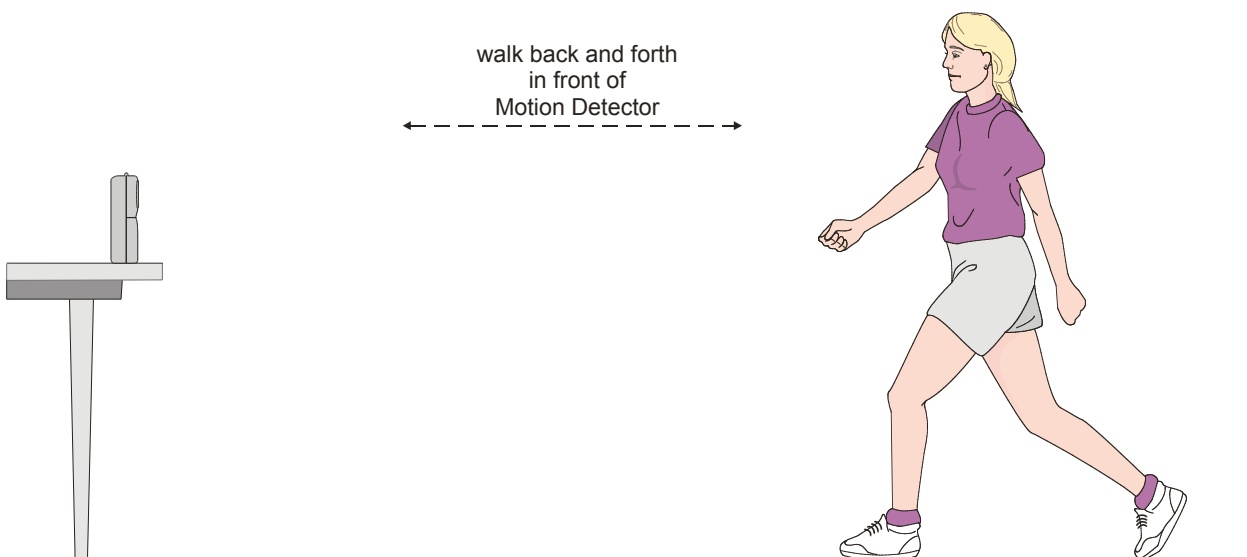# Make a Graph

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 plot real time graphs 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, the interface can determine the distance to the object; that is, its position. It can then use the change in position to calculate the object's velocity and acceleration. All of this information can be displayed in a graph. A qualitative analysis of the graphs of your motion will help you understand the concepts of kinematics.

walk back and forth
in front of
Motion Detector

OBJECTIVES

- Understand the relationship between shape of kinematics graphs and the motion that produced them

MATERIALS

Macintosh or Windows Computer	meter stick
Logger *Pro* or Logger Lite	masking tape
Motion Detector or Go! Motion	

PROCEDURE

1. Find an place to locate your motion detector that has an open area at least 4 m long in front of it. Use short strips of masking tape on the floor to mark distances of 1 m, 2 m, and 3 m from the detector.

2. If your Motion Detector (or Go! Motion) has a switch, set it to Normal as shown on the right. Connect the Motion Detector to DIG 1 of LabPro (or connect the Go! Motion to the computer with the USB cable). Launch Logger Pro or Logger Lite and choose New from the File menu. If you have an older sensor that does not auto-ID, you will need to manually set up the sensor.
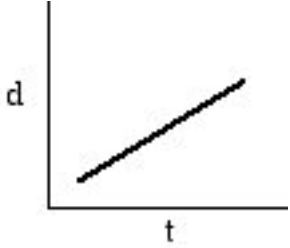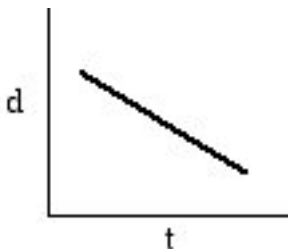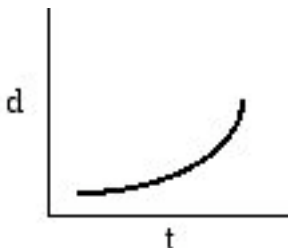
3. In Logger Pro, open the file in Physics with Vernier: "01a Graph Matching". If you are using Logger Lite, open the file in Middle School with Vernier: "33a Graphing Motion".

4. In Logger Pro, click on the "stopwatch" icon. (In Logger Lite, click on **Experiment > Data Collection…**) In the window that appears, change the data-collection length to 10 seconds. Click on [Done] to set this new collection time.

    ### Part I Preliminary Experiments

5. Stand in front of the motion detector and monitor the position readings on the Setup screen as you move back and forth. Confirm that the values make sense.

6. Make a graph of your motion when you walk away from the detector with constant speed. To do this, stand about 1 m from the detector and start data collection. Walk backward, slowly away from the detector after data collection begins.

7. How will you know you have obtained a good graph? When you get a good graph, describe the shape of that graph.

8. Once you get a good graph, in Logger Pro click on **Experiment > Store Latest Run** store that run. In Logger Lite, click on the file cabinet icon in the menu bar. You are now ready to collect a second run.

9. What will the distance *vs.* time graph look like if you were to walk backwards at a faster speed? Check your prediction by repeating step 6 but walking backward a bit faster.

10. How can you tell the difference between the first and second run? What differences were there between the two graph lines? Can you begin to draw some conclusions about the shape of position vs. time graphs and what they might indicate about your motion?

11. When you are finished with this part, click on **Data > Clear All Data**.
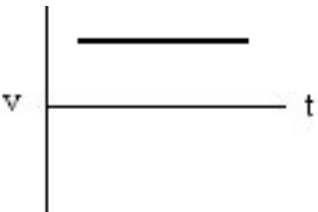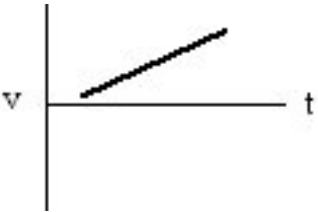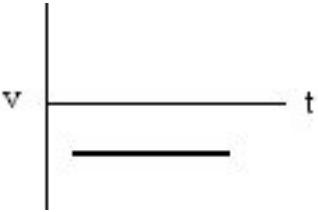
Part II Making Position *vs*. Time Graphs

12. In the spaces below, you will see a series of graphs on the left-hand side. Using your Motion Detector, move until you have created a graph that matches the shape of the one shown. On the right-hand side, describe how you moved in order to create that graph.
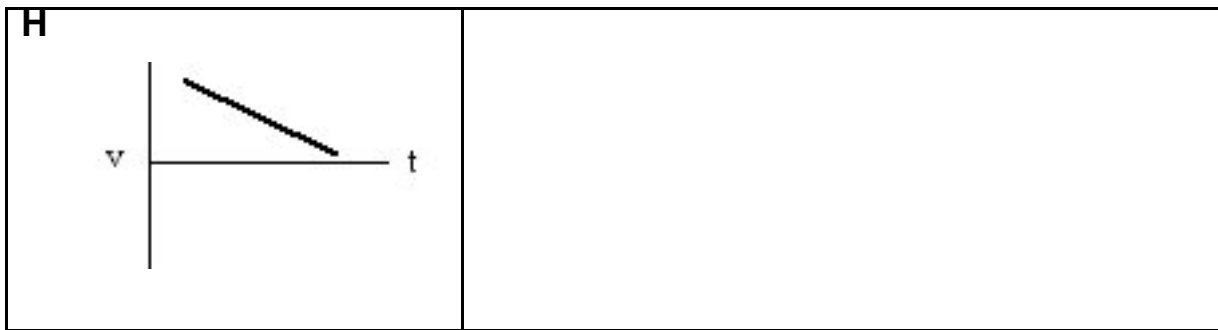
A	
B	
C	
D	

13. Go to the **Analysis** section, Part II to apply your new knowledge.

Part III Making Velocity vs. Time Graphs

14. Clear the data by clicking on **Data > Clear All Data**. Click on the label for the vertical axis, **Position**. In the menu that appears, tap on **Velocity** to change the graph to a velocity vs. time graph.

15. Repeat step 6, observing the velocity vs. time graph you obtain. Describe the shape of the graph and how it tells you about your motion.

16. Store that run the same way you did in step 8, then repeat step 6 but moving at a faster speed. Compare the two graph lines and compare them to your motions while creating each.

17. Store this second run the same way you did in step 8. Repeat step 6 but move towards the motion detector rather than away from it. How does this change the shape of your graph line? How does it change the comparison between your first run and your last run? Compare the results with the motions you made to create the graphs.

18. Click on **Table > Clear All Data**. In the space below, you will see graphs on the left-hand side. Use your Motion Detector to move until you have created a graph that matches the one shown. On the right-hand side, describe how you moved in order to create that graph.
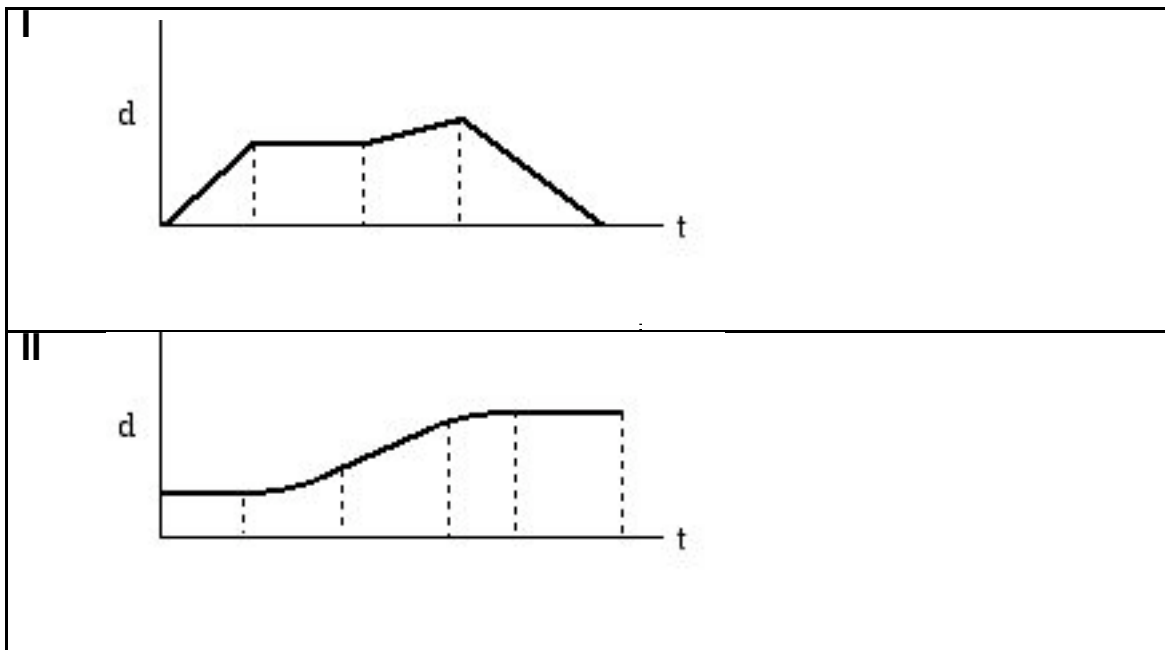
E	
F	
G	

19. Go to the **Analysis** section, Part III to apply your new knowledge.

20. Remove the masking tape strips from the floor and return the Go! Motion or Motion Detector and LabPro to the place your teacher requests of you.

ANALYSIS
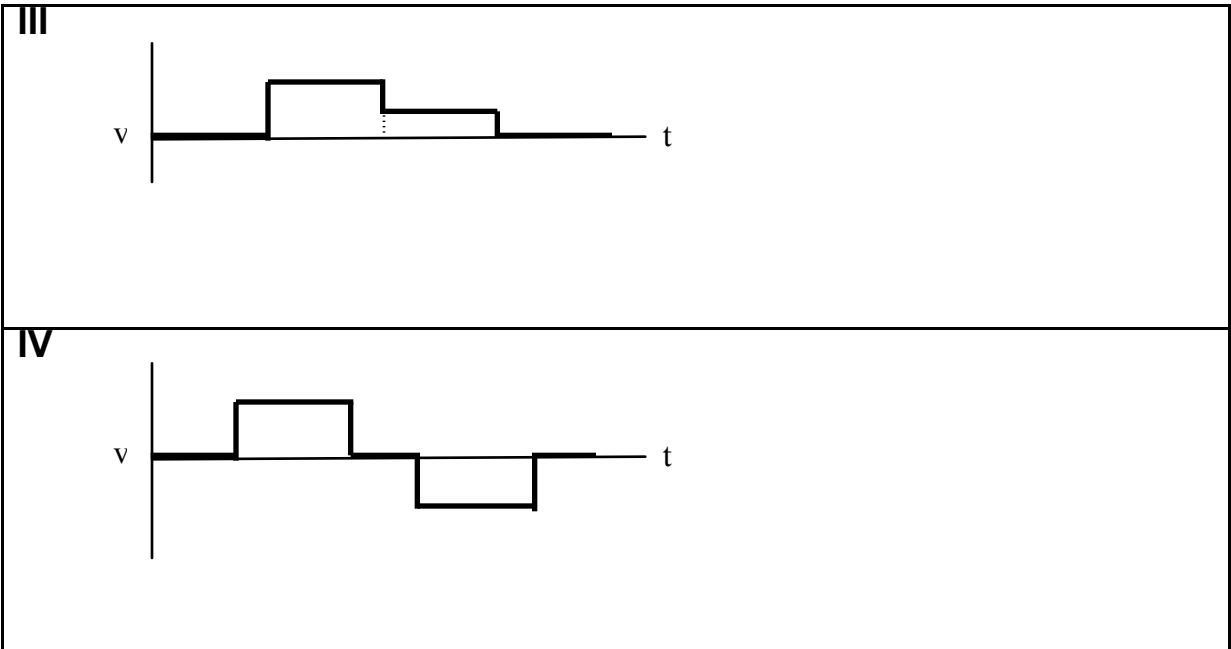
Part II Position *vs.* Time Graphs

1. Two Position vs. Time graphs are shown below. For each, describe the motion of the student who created the graph.

2. Return to the procedure and complete Part III.

Part III Velocity *vs*. Time Graphs

1. Two Velocity vs. Time graphs are shown below. For each, describe the motion of the student who created the graph.

C.Bakken

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