INVESTIGATION 1: DISTANCE (POSITION)-TIME GRAPHS OF YOUR MOTION

The purpose of this investigation is to learn how to relate graphs of the distance as a function of time to the motions they represent.

You will need the following materials:

- computer-based laboratory system
- motion detector
- RealTime Physics Mechanics experiment configuration files
- number line on floor in meters (optional)

How does the distance-time graph look when you move slowly? Quickly? What happens when you move toward the motion detector? Away? After completing this investigation, you should be able to look at a distance–time graph and describe the motion of an object. You should also be able to look at the motion of an object and sketch a graph representing that motion.

Comment: "Distance" is short for "distance from the motion detector." The motion detector is the origin from which distances are measured. The motion detector
- detects the closest object directly in front of it (including your arms if you swing them as you walk),
- transfers information to the computer via the interface so that as you walk (or jump, or run), the graph on the computer screen displays your distance from the motion detector,
- will not correctly measure anything closer than some distance (usually specified by the manufacturer).

When making your graphs, don't go closer than this distance from the motion detector.

Activity 1-1: Making and Interpreting Distance–Time Graphs

1. Be sure that the interface is connected to the computer, and the motion detector is plugged into the appropriate port of the interface. Open the experiment file called Distance (L01A1-1a) to display distance (position) vs. time axes.

2. If you have a number line on the floor and you want the detector to produce readings that agree, stand at the 2-m mark on the number line, begin graphing, and have someone move the detector until the reading is 2 m.

3. Begin graphing and make distance–time graphs for different walking speeds and directions, and sketch your graphs on the axes.

   a. Start at the 1/2-meter mark and make a distance-time graph, walking away from the detector (origin) slowly and steadily.

   b. Make a distance-time graph, walking away from the detector (origin) medium fast and steadily.
c. Make a distance-time graph, walking toward the detector (origin) slowly and steadily.

d. Make a distance-time graph, walking toward the detector (origin) medium fast and steadily.

**Question 1-1:** Describe the difference between a graph made by walking away slowly and one made by walking away quickly.

**Question 1-2:** Describe the difference between a graph made by walking toward and one made walking away from the motion detector.

**Comment:** It is common to refer to the distance of an object from some origin as the *position* of the object. Since the motion detector is at the origin of the coordinate system, it is better to refer to the graphs you have made as *position-time* graphs rather than distance-time graphs.

**Prediction 1-1:** Predict the position-time graph produced when a person starts at the 1-m mark, walks away from the detector slowly and steadily for 5 s, stops for 5 s, and then walks toward the detector twice as fast. Draw your prediction on the left axes below using a dashed line.

Compare your predictions with those made by others in your group. Draw your group's prediction on the left-hand axes below using a solid line. (Do not erase your original prediction.)
4. Test your prediction. Open the experiment file called *Away and Back* (L01A1-1b) to set up the software to graph position over a range of 2 m for a time interval of 15 s.

Move in the way described in Prediction 1-1, and graph your motion. When you are satisfied with your graph, draw your group's final result on the right axes above.

**Question 1-3:** Is your prediction the same as the final result? If not, describe how you would move to make a graph that looks like your *prediction*.

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**Activity 1-2: Matching a Position–Time Graph**

By now you should be pretty good at predicting the shape of a position–time graph of your movements. Can you do things the other way around by reading a position–time graph and figuring out how to move to reproduce it? In this activity you will move to match a position graph shown on the computer screen.

1. Open the experiment file called *Position Match* (L01A1-2). A position graph like that shown below will appear on the screen. Clear any other data remaining from previous experiments.

![Position-Time Graph](image)

**Comment:** This graph is stored in the computer so that it is persistently displayed on the screen. New data from the motion detector can be collected without erasing the Position Match graph.

2. Move to match the Position Match graph on the computer screen. You may try a number of times. It helps to work in a team. Get the times right. Get the positions right. Each person should take a turn.
Question 1-4: What was the difference in the way you moved to produce the two differently sloped parts of the graph you just matched?

Activity 1-3: Other Position–Time Graphs

Note: Clear the Position Match graph from the screen before moving on.

1. Sketch your own position–time graph on the axes which follow with a dashed line. Use straight lines, no curves. Now see how well someone in your group can duplicate this graph on the screen by walking in front of the motion detector.

2. Draw the best attempt by a group member to match your position–time graph on the same axes. Use a solid line.

3. Can you make a curved position–time graph? Try to make each of the graphs shown below.

4. Describe how you must move to produce a position–time graph with each of the shapes shown.

Graph A answer:

Graph B answer:
Graph C answer:

**Question 1-5:** What is the general difference between motions that result in a *straight-line* position–time graph and those that result in a *curved-line* position–time graph?