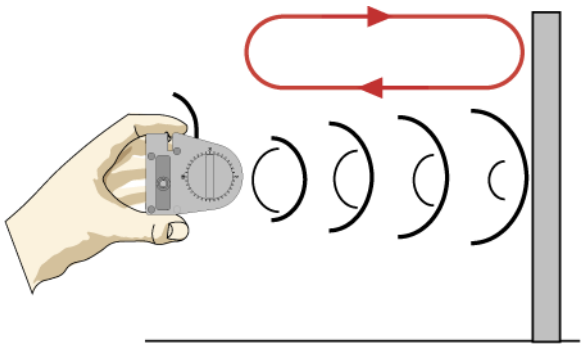
17 Position-Match Graph

Purpose

Explore graphs of motion (position versus time). Use a Motion Sensor to measure your motion as you move back-and-forth in front of a flat reflector along a straight line at different speeds. The challenge is to move in such a way that a plot of your motion will 'match' the position versus time graph that is provided for you. Use the Xplorer GLX to record and display the data.

Background



When describing the motion of an object, knowing where it is relative to a reference point, how fast and in what direction it is moving, and how it is accelerating (changing its rate of motion) is essential. A sonar ranging device such as the PASPORT Motion Sensor uses pulses of ultrasound that reflect from an object to determine the position of the object. As the object moves, the change in its position is measured many times each second. The change in position from moment to moment is expressed as a velocity (meters per second). The change in velocity from moment to moment is expressed as an acceleration (meters per second per second).

The position of an object at a particular time can be plotted on a graph. A graph is a mathematical picture of the motion of an object. For this reason, it is important to understand how to interpret a graph of position versus time. In this activity you will plot a graph of your motion in real-time, that is, as the motion is happening.

Materials

Equipment	
• PASPORT Xplorer GLX	• Pulley Mounting Rod
• PASPORT Motion Sensor	• Motion Sensor Reflector Board (optional)

Safety Precaution

- Follow all directions for using the equipment.

Pre-Lab Questions

1) What will happen on a real-time graph of position versus time as you move the Motion Sensor away from a wall?

2) What will happen on the real-time graph of position versus time as you move the Motion Sensor toward a wall?

Procedure

Equipment Setup

1) Move the switch at the top of the Motion Sensor to the Stick Figure icon.

2) Screw a pulley mounting rod into the tripod socket on the back of the Xplorer GLX.

3) Mount the Motion Sensor on the pulley mounting rod as shown. Turn the head of the Motion Sensor so it faces in the same direction as the top end of the Xplorer GLX.

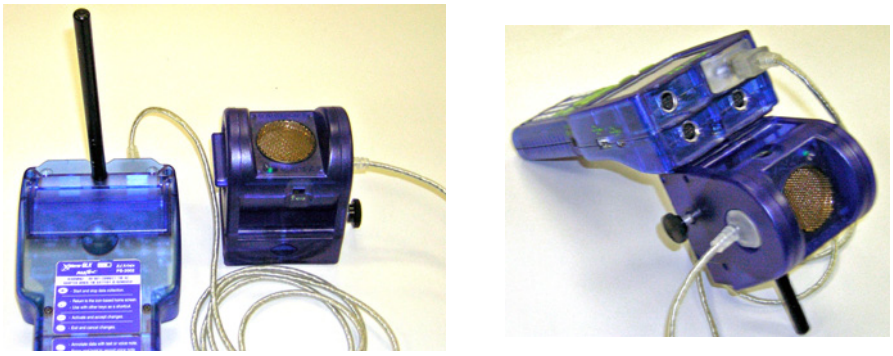


Fig. 3: Equipment setup

Xplorer GLX Setup

1) Turn on the GLX (⏻).

2) Press ✓ from the **Home** screen to open the **Data Files** display. Use the arrow keys to highlight the **Flash** folder, then use ▽ to highlight the file:

PositionMatch

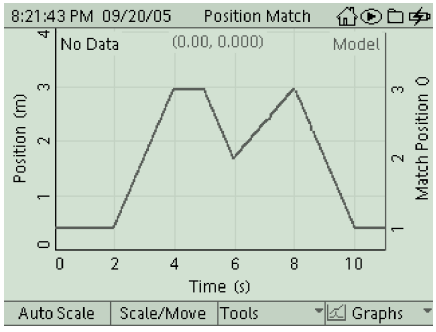


Fig. 2: PositionMatch file

3) Press F1 to open the file, then press ⌂ F1 to open the graph display.

The file has a 'target' graph of Position (m) versus Time (s) for you to match.

4) Connect the Motion Sensor to one of the sensor ports on the top end of the GLX.

Record Data

1) Stand in front of a wall or stand in front of a lab partner holding a flat board.
2) Observe the Graph on the Xplorer GLX.
3) Press Start (►) on the GLX to begin recording data.
4) Move back-and-forth relative to the wall in order to match the position-time graph.
5) After 11 seconds, press Stop (►) to end data recording.

Analyze

Record results in your lab notebook/data table as you complete your analysis.

1) Press (F4) and select "Graph 2" as in the picture.
2) The "error" graph will give a score in units of "m*s." The lower the score, the better you were at matching the graph of position versus time.
3) Press the F4 button and select "Graph 1" to return to the original graph.
4) Use the arrow buttons and Activate button (✓) to navigate to and select the Run number as in the picture. Delete the data run, if necessary.
5) Repeat the previous steps several times and record your best score.

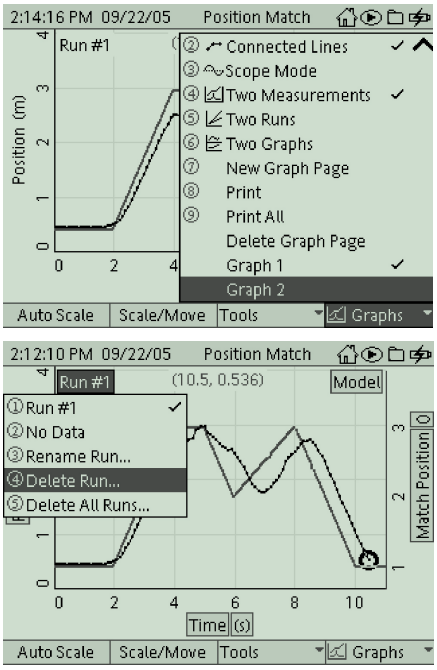


Fig. 5: Analysis

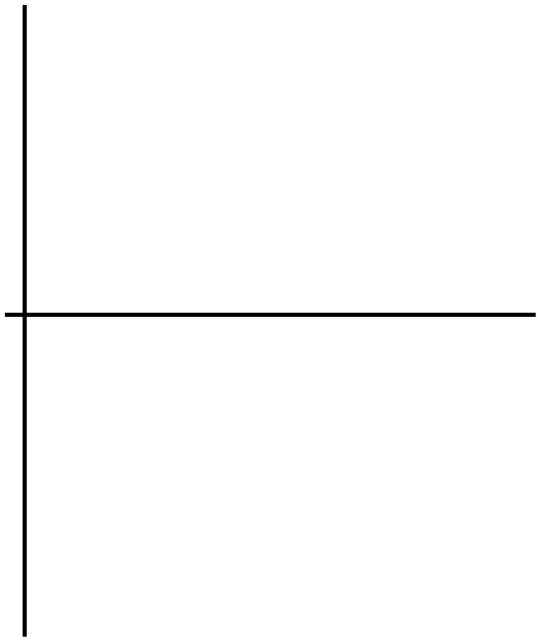
Data

Best (lowest) Position-Match Score = _____

Analysis and Synthesis Questions

1) How well did your motion graph match the provided graph.
2) What was the meaning of the part of the position plot where the slope was positive (upward)?
3) Were certain parts of the plots easier to match than other parts? Why or why not?

4) Make a sketch of a velocity versus time graph from the position versus time graph including labels for the y- and x-axes.



5) Write a short paragraph that describes your motion in the graph. Include speeds, directions, positions, etc. Be as descriptive as possible.