Position and Velocity

Introduction

The purpose of this experiment is to investigate the relationship between position and velocity. A Motion Sensor is used to measure the position of the motorized cart on the track. Graphs of position vs. time are created, and the velocity is calculated by measuring the slopes of these graphs.

Three different scenarios are implemented to investigate the differences between constant velocity, average velocity, and instantaneous velocity.

Equipment

Qty	Items	Part Number
1	PASCO Motion Sensor	PS-2103A
1	PAScar Dynamics System	ME-6955
1	Motorized Cart	ME-9781
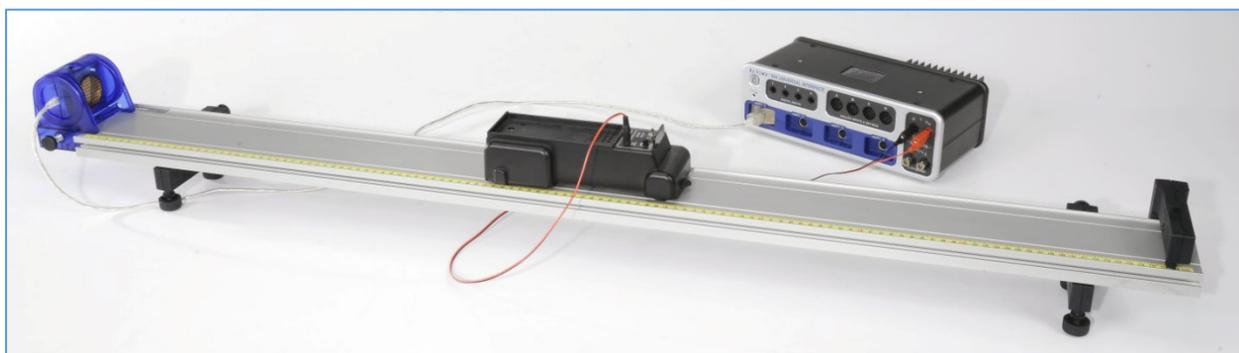
Set-up

1. Set up the track with feet and bumper as shown in Figure 1. Attach the Motion Sensor to the track and connect it to the 850. Make sure the range switch is on the "cart" icon.

2. Plug the motorized cart power cord into the 850 Output #1, and make sure the switch on the cart is in the OFF/EXTERNAL setting.

3. Set a Stop Condition (on the Sampling Bar) to be based on the measurement Position so when the Position is above 0.9 m, sampling will stop.

4. Create a graph of Position vs. Time.

Procedure - Constant Velocity

1. Position the back of the Motorized Cart at the 20 cm mark. This will be the starting position of the Cart for EVERY run. Always return the Cart to this position.

2. Set the 850 Output is set on DC with a voltage of 2 Volts. Turn the Output ON and OFF to ensure that everything works.

3. Start recording data. Turn the Output ON and OFF to ensure that you are getting good position data.

4. You can delete unwanted runs using the Delete Run feature in the Control Palette at the bottom.

5. When everything looks good, click on Auto in the Output Control. This will cause the output to automatically turn on when you start recording. You can stop recording anytime you wish, but there you have also built in a stop condition that will stop the Cart before it reaches the bumper.

6. Get a single good run of position vs. time for the Cart, then repeat for a voltage of 3 V and 4 V.

7. Get three good runs on your graph.

Measuring Slopes

1. Make run #1 active by clicking on it in the Graph Legend. Select a linear Curve Fit from the upper tool palette.

2. What is the physical meaning of the slope? Does it have units?

3. How linear is your data? Was this truly constant velocity?

4. What is the physical meaning of the y-intercept on the graph? Does it have units?

5. Do a linear Curve Fit on the other two curves.

Average Velocity – Non-constant Velocity

1. Set the 850 Output on a Square Wave with a voltage Amplitude of 2 V, and a Voltage Offset of 2 V. With the Frequency set at 1 Hz, the Cart will run for 1/2 second, off for 1/2 second, on for 1/2 second, etc. With the Auto button clicked, the Cart should stop before it reaches the end.

2. Start recording. Get a single good run of position vs. time for the Cart. You can delete unwanted runs using the Delete Run feature in the Control Palette at the bottom.

3. Calculate the average velocity of the Cart for the entire run by measuring the total Δx and Δt.

4. Select a linear Curve Fit. How does this speed compare to your calculation of the total average?

5. Use the Selection Tool to highlight a small section of the data when the Cart is moving at a constant velocity. How does this velocity compare to the average for the entire run?

Instantaneous Velocity

6. Confirm that the 850 Output is set on Positive Ramp with a Voltage Amplitude of 4 Volts, and a Voltage Offset of 1 Volt. With the Frequency set at 0.1 Hz, the Cart will ramp up its speed over a 10 second period, but the automatic stop should stop it before it reaches the end.

7. Start recording. Get a single good run of position vs. time for the Cart. You can delete unwanted runs using the Delete Run feature in the Control Palette at the bottom.

8. Calculate the average velocity of the Cart for the entire run by measuring the total Δx and Δt.

9. Select a linear Curve Fit. How does this speed compare to your calculation of the total average?

10. Use the Selection Tool to highlight only about 1 second of data. You can then move this selection to find the average speed at different locations.

11. Move the Selection Tool to the beginning data, and reduce the size of the box while watching the slope. In the limit that you reduce this size to as small as possible, the slope approaches the instantaneous velocity of the Cart. Using this method, measure the minimum and maximum speed of the Cart.

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