PHY 120 Lab 2: Kinematic Graphs II[1]

Name ______________________ Section__________ Date __________

Velocity and Acceleration Graphs

The rate of change of velocity is known as acceleration. In this part of the lab you will create and interpret velocity vs. time and acceleration vs. time graphs for some relatively simple motions. In the following activities you will use a fan-cart on a track to produce motion in which velocity is changing at a constant rate. Mount the motion sensor on the track at the $x = 0$ end.

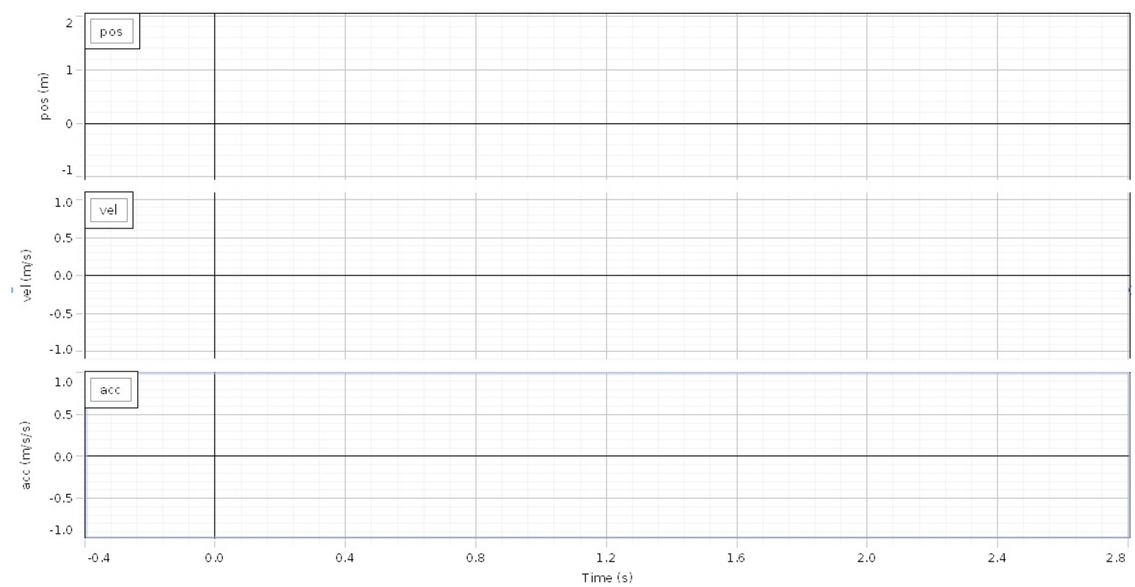
Speeding Up

Open Capstone experiment kin_9.

1. Set the fan cart on the track near the x = 0 end of the track, with its fan end toward the motion sensor so that it will speed up in the positive x-direction. Turn on the fan to low power. Release the cart from rest. Try doing this a couple of times without recording the motion with the computer. Turn off the fan unit when not observing the motion to save the batteries.

a. Predict the position vs. time, velocity vs. time, and acceleration vs. time graphs for the motion of the fan cart. Using *dashed lines*, sketch your predictions on the axes provided below.

Test your predictions by recording the motion with the motion sensor. Start recording data just after the cart is released. Turn off the fan unit when not recording motion to save the batteries. Repeat, if necessary, until you get nice graphs. Using *solid lines*, sketch the observed graphs on the same axes as your predictions.



b. How does your position vs. time graph differ from the position vs. time graphs for constant velocity motion that you observed earlier?

[1] 1993-94 P. Laws, D. Sokoloff, R. Thornton. Supported by the National Science Foundation and U.S. Department of Education (FIPSE). These materials have been modified for use at Union College.

c. What feature of your velocity vs. time graph indicates that the cart was speeding up?

d. According to the acceleration vs. time graph, during the time that the cart is speeding up, is the acceleration positive or negative? Explain how you know.

e. According to the velocity graph, how does the velocity vary in time as the cart speeds up? Does it increase at a steady rate or in some other way? Is the graph linear? Is the velocity proportional to time?

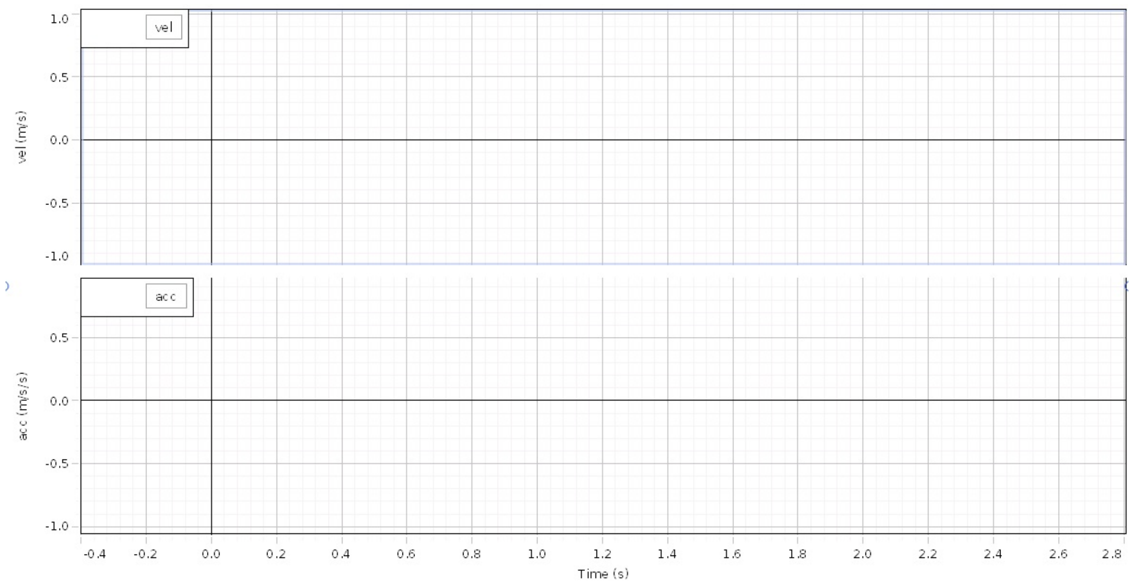
f. How does the acceleration vary in time as the cart speeds up? Is this what you expect based on the velocity graph? Explain.

Slowing Down in the Positive Direction

Open experiment kin_10.

2. Suppose you reverse the direction of the fan cart. Now if you start the cart near the sensor and give it a push in the positive direction, it will travel in the positive direction while slowing down. Try doing this a couple of times without recording the motion with the sensor. Be sure to stop the cart (carefully) before it changes direction.

a. Predict the velocity vs. time and acceleration vs. time graphs for this motion. Sketch your predictions on the axes below using *dashed lines*. Under these circumstances do you expect the acceleration to be positive or negative (after it is released)? Circle your prediction:
positive or negative.



Test your prediction by recording the motion with the motion detector. Place the cart on the track near the sensor and set the fan on low. Give the cart a gentle push so that it coasts over most of the length of the track and start recording data just after the push. Have a partner stop the cart before it changes direction. (Be sure that your hand is not between the cart and the sensor, and that your fingers don't touch the fan.) You may have to try a few times to get a good run. Plot your observations with *solid lines* on the axis.

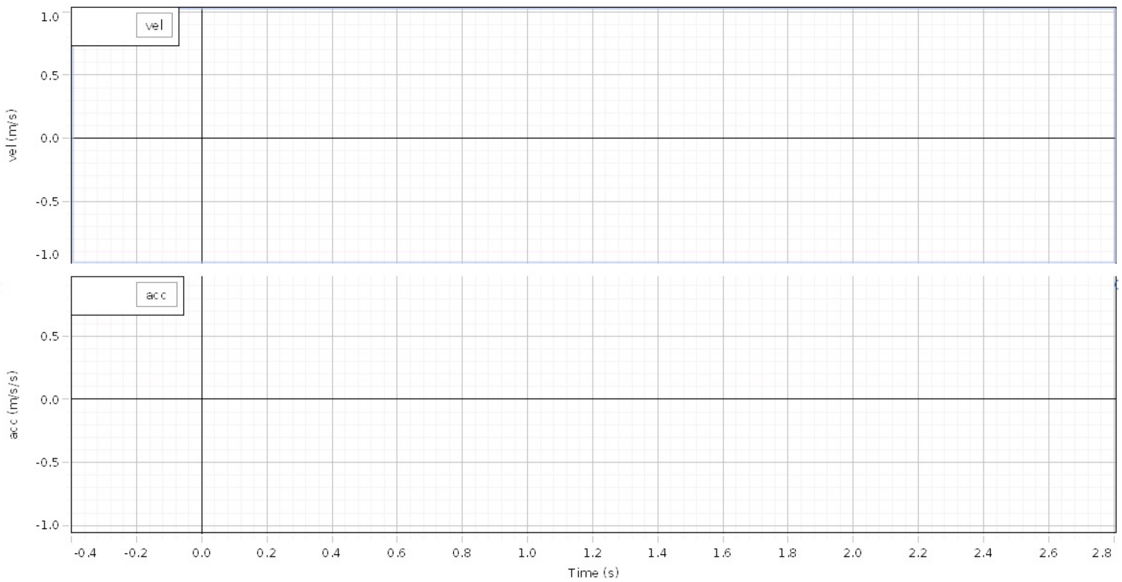
b. How can you tell the sign of the acceleration from a velocity vs. time graph?

c. How can you tell the sign of the acceleration from an acceleration vs. time graph?

Slowing Down in the Negative Direction

3. Consider the situation in which the fan cart is moving in the negative direction and slowing down.

a. Sketch your predictions for the velocity vs. time and acceleration vs. time graphs on the axes provided using *dashed lines*. Predict the sign of the acceleration in this case. Test your predictions and sketch the observed graphs on the same axes using *solid lines*.



b. Calculate the acceleration from two points on the velocity graph. Show your work below.

c. How does your calculated value for the acceleration agree with the measured value? The best way to make this comparison is to calculate the % difference given by

$$\%\,difference = \frac{measured\,value - calculated\,value}{calculated\,value} \times 100\,\%.$$

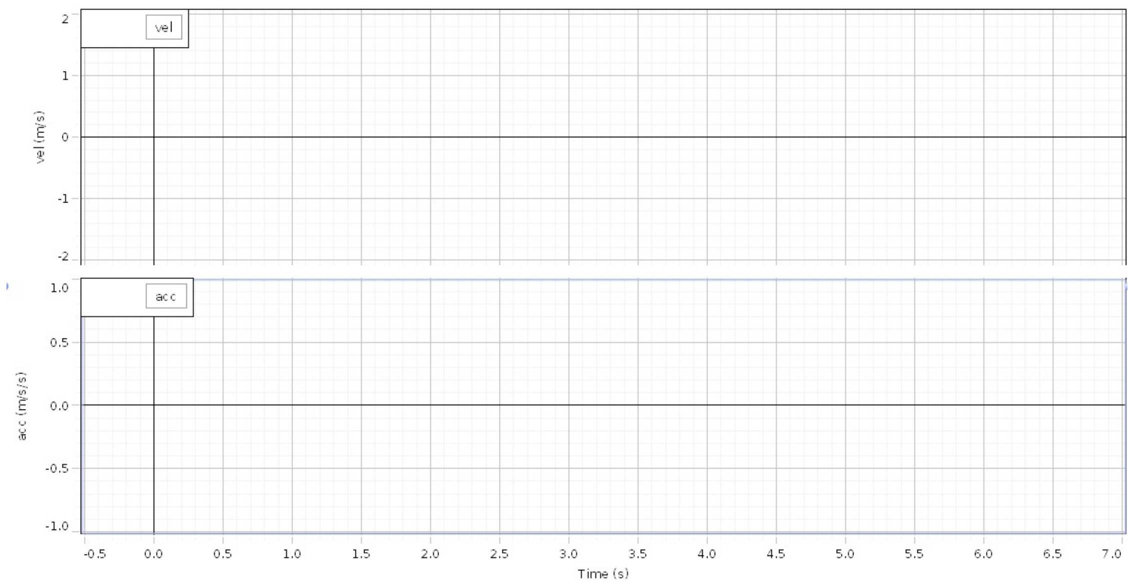
Reversing Direction

What happens when the cart slows down, reverses its direction and then speeds up in the opposite direction. How is its velocity changing? What is its acceleration? The setup should be as before. The fan will be set to low speed.

Open experiment kin_12.

4. Suppose you place the cart near x = 0, with the fan directed so that the cart will slow down and reverse direction after being given a push in the positive direction. Try it first without using the computer.

a. Sketch your predictions for the velocity and acceleration graphs on the axes provided using *dashed lines*. Your sketch should represent the motion beginning just after you release the cart and ending just before you catch the returning cart.



Test your prediction. Give the cart a push just after you turn on the motion detector. Try to have the cart cover most of the length of the ramp. (Be sure that your hand is not between the cart and the detector.) Sketch the observed graphs on the same axes using *solid lines*.

b. For each part of the motion–slowing down, at the turning point, and speeding up, indicate below whether the velocity is positive, zero, or negative by circling the appropriate sign in the table. Also indicate whether the acceleration is positive, zero, or negative.

	Slowing Down			Turning Point			Speeding Up		
Velocity	+	0	-	+	0	-	+	0	-
Acceleration	+	0	-	+	0	-	+	0	-

c. On the graphs of the observed motion, label the following times with letters:

A - When you started pushing the cart.

B - When you stopped pushing the cart.

C - When the cart reached its farthest point along the track.

D - When the cart had zero velocity.

d. According to your acceleration graph, what is the acceleration of the cart at the instant it reaches its farthest point along the track? What is its velocity at this point?