LAB 1. VELOCITY AND ACCELERATION

Supplies: computer with installed; Science Workshop 750 interface; USB to serial converter cable; PASCO Motion sensor II; detachable cable with two color-coded phone plugs; Condor power supply; dynamics cart; grooved aluminum track; books or blocks to elevate one end of the track; light aluminum pie pan

Lab Activities

Configuring the system

1. Connect the Condor power supply to the wall outlet and the Science Workshop interface. Connect the USB to serial cable to a USB port in the computer and the serial port in the back of the interface. Connect the detachable cable to the socket in the motion sensor. Plug the yellow phone plug into socket 1 on the interface, and plug the black phone plug into socket 2. Make sure the interface is turned on (the switch is in the back).
2. Launch the Data Studio program. If it brings up a "What do you want to do?" window, select "Create Experiment." Then select the "Setup" button. If necessary, do what it says to connect to the interface. To recognize the motion sensor, click on channel 1 in the picture of the interface box. It should auto-populate position, velocity, and acceleration in channels 1&2. Set the sample rate to at least 50 Hz.
3. Now you are ready to take data!

Activity1. Rolling cart

1. Make the track into a ramp by propping books or blocks under one end.
2. Put the dynamics cart at the top of the track. Place the motion sensor at the top of the track, pointing down.
3. Start data collection and release the cart.
4. Catch the cart or place a shock-absorbing barrier at the bottom of the track.
5. Stop data collection.
6. To see the data, double-click "Graph" in the "Displays" window at the lower left of the screen. Select "position." Double-click "Graph" again, and select "velocity." You now should have a position-time graph and a velocity-time graph. Practice moving, resizing, rescaling, and re-centering the plots.
7. You can clear a graph by selecting the data set name in the graph and then hitting the "backspace" key. To clear the data, select the data name in the "Data" window and then "backspace."
8. Practice capturing data for a downhill roll several times, until you have a data set that you like.
8. Then export the data to a file by selecting File > Export Data. In the resulting window, select "Position." Then name and place the file. If you have a USB drive, you can save your file directly to it. Otherwise, save it to the computer and transfer it to yourself.
9. In the same manner, export the velocity-time data to a file.

10. Next, record a trajectory of the cart coasting up and then down the ramp. Before taking data, practice pushing the cart so that you can push it so that it coasts almost all the way up the ramp before slowing and reversing direction to go down the ramp.
11. Start data collection and expertly push the cart so that it coasts up and down the track, all recorded by the sensor. When you have a good run, export the data.

Activity 2. Falling Pie Pan

1. Place the motion sensor on the floor with its transducer facing up. Hold a pie pan high in the air directly above it.
2. Start data collection and drop the pie pan, so that it falls onto the detector. Stop data collection.
3. When you have a data set you like, export the position-time and velocity-time data to a file.

Processing, Analysis, and Interpretation

Activity 1. Rolling Cart

1. Open your data files with a spreadsheet. Plot the data (x vs. t) and (v vs. t).
2. In the x vs t plot, select only the points that you believe correspond to the cart coasting under the influence of gravity. In your spreadsheet, fit the points with a second-order polynomial ($x = A\,t^2 + B\,t + C$.)
3. Record the values of the parameters A, B, and C.
4. Determine how to find the physical quantities x_0, v_0, and a from the fit parameters A, B, and C.
5. Generate a column of "best-fit" points x_{calc} by applying the formula to the time data values.
6. Generate another column of "residuals," $x - x_{\text{calc}}$.
7. Make a residuals plot, $x - x_{\text{calc}}$ vs. t. Check if the residuals appear to be random scatter, or if there is a pattern to them.

Activity 2: Falling Pie Pan

1. Open your data file with a spreadsheet. Plot the data (x vs. t) and (v vs. t).
2. Inspect the plots to see if there is a region of constant acceleration, or of constant velocity.

Lab Report

The report for this first lab should not be lengthy. It should not take long for me to read it! It will contain the following sections.

Methods: Here, describe the apparatus and procedure. Specifically, what was the configuration of the cart, track, and detector for the runs you recorded?

Data: Display the position-time graphs and velocity-time graphs. Be sure that they are clearly identified and that the graph axes are labeled with quantities and units.

Discussion: Identify and describe the times within the runs that you recorded in which:

- The velocity is constant
- The acceleration in constant
- The acceleration is changing.

For the time(s) that the velocity is constant, tell me what the velocity is. For the time(s) that the acceleration is constant, tell me what the acceleration is.