WiiExperiment – Head-on Collisions

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http://wiiexperiment.org

Ingredients:

two Wiimotes, one computer, two carts, long track, masses for carts, scale to weigh carts

Brief Instructions:

Open two graph displays and arrange them so you can see both as well as possible.

Set up two carts the same way (with or without extra masses). Tape one Wiimote to each cart. Make sure the cart is taking the impact but that the Wiimote does not slide on the cart. Weigh the carts with the Wiimotes attached

Compare the accelerations of the two carts when they collide. Does it matter whether both carts are in motion before the collision, whether their speeds are the same, whether there is a spring between the carts, which cart the spring is attached to.

What happens of you start with the two carts together with a spring (or two) compressed between them?

How can you calibrate two Wiimotes for this sort of experiment?

You may want to save data to a file using the CSV option and then open a spreadsheet (e.g. Excel or OpenOffice.org) and use that to open the file you just saved (comma delimited). Try taking ratios of accelerations. What do you see in the data? What is this ratio?

Detailed Instructions – qualitative analysis:

Starting up WiiExperiment

1. Set up two Wiimotes. Set each Wiimote to show a graph.

The Experiment

1. Securely attach (tape or string) one Wiimote to each cart.
2. Put one cart near the middle of the level track. (It should stay in place.)
3. Put the other cart several cart-lengths away from the first oriented so rigid, non-sticky surfaces will collide.
4. Push the second cart toward the first and watch the graphs as the collision occurs. How big are the acceleration spikes in each graph? Are they of similar size?
5. Repeat, but alter the carts so that they collide some sort of spring between them.
6. Repeat, but changing to some method of making the carts attach to each other.

Detailed Instructions – quantitative analysis:

Starting up WiiExperiment

1. Set up two Wiimotes. Set each Wiimote to show a graph and to save to CSV.

Setting up the experiment

1. Securely attach (tape or string) one Wiimote to each cart.
2. Put one cart near the middle of the level track. (It should stay in place.)
3. Put the other cart several cart-lengths away from the first oriented so rigid, non-sticky surfaces will collide.
4. Do the next steps quickly to avoid excessively large file sizes. (100 lines per second adds up quickly!)
   a) Click both start buttons in the file output windows that appeared when you selected CSV output.
   b) Knock sharply on the track between the carts as a time-stamp for aligning the two output files. (You can't have clicked both start buttons simultaneously, so the files will start at slightly different times.)
   c) Push the second cart toward the first cart.
   d) Once the collision is over, click stop in each window.
5. In each window, click "Save". Give the files different names and save them.

Analyze the data

1. Open a spreadsheet program (OpenOffice.org or Excel, for instance) and ask the program to open each of the files you just saved.
2. Copy one set of data and paste it into the other file so you have one spreadsheet with data from both carts in it.
3. Make an xy graph of each coordinate for each cart. You should end up with 6 sets of data on your graph. Display legends so you can keep track of the various sets.
4. For each cart, find the spikes showing where you knocked on the track. Hover your mouse over a data point and you will see information about that will help you locate the rows in your data. Delete rows of data in all sets before the knock. Now, the times for the two carts should be synchronized.
5. Use your graph to figure out which two sets of data are on the same axis as the motion of the carts.
6. Make a new column in your spreadsheet showing the ratio of the two sets you found in the previous step for every row of data during the collision (which should be the spikiest part of the data).
7. Graph the new data against time. What do you notice about the variations in this line? What do you notice about the average value of the ratio?
8. Repeat for different masses on each cart and revisit the questions asked in step 7.