Newton's Second Law

Choose group roles and record them for your reports.

Obtain your ramp and GLX interface with sensors. Connect a motion detector and force probe to the GLX. Connect the GLX to the computer via the USB cable. Prepare a display in Capstone that shows a velocity vs. time graph and Force vs. time graph. (To add a graph to the display, click on the xy axis with the green star.)

Position the motion detector at one end of the track and an end stop at the other end. Clamp a pulley to the end opposite the motion detector on the outside of the end stop.

Attach a 50g mass to one end of a string that is about 1.2 m long. Zero out the force sensor. Hang the string and mass from the force sensor. Record the force measured. (Hardware setup allows you to change the sign of the measurement if necessary.) Use a triple-beam balance to measure the mass of the mass plus the string. *How is this measured mass related to the force you have measured with the force sensor?*

Measure the mass of a cart with a triple-beam balance and write this on a small piece of masking tape, and label the cart with this mass. Do the same for each of your black masses.

Run the piece of string tied to the mass over the pulley, through the **top** hole of the end stop and attach it to the silver cart, on the end opposite the plunger. Adjust the position and height of the pulley so the string has an unimpeded path through the end stop. Check that the string is level. Check that the ramp is level. Adjust the feet to make it level.

Place one ~250 g mass in the cart. Measure the acceleration of the cart + mass + hanging mass + string, using the appropriate fit of your **v vs. t** graph. You will get best results if you choose a smooth portion of the graph which is as large as possible. Be sure to set the switch on the motion sensor to cart (close up), and to point the sensor directly at the cart.

Repeat the measurement of acceleration with ~500 g, ~750 g, and ~1000 g riding on the cart.

Find *ma* for each mass combination, where *m* is the total mass of the moving system. *Describe in words what makes up this total moving mass.*

Find the average of *ma* for these four systems; *how does this compare with the force you measured with the force sensor? Are your results consistent with Newton's* 2^{nd} *Law?*

Calculate an error in your average by finding the sum of the squares of the deviations of the data from their average, taking the square root, and dividing by N-1 (the number of data minus one as the mean value is not an independent datum), which for four measurements is

$(\{[(ma)_1\text{-average}]^2 + [(ma)_2\text{-average}]^2 + \ldots\})^{½}/3.$

Can this error account for any difference you have found between the force you measured and the average? If not, can you think of any other possible sources of this difference? Ask an instructor to check your work.

Repeat the entire experiment using a 100g mass as the hanging weight.

Reports

Have your recorder/checker enter the measurements (data) from the experiment into an Excel spreadsheet (be sure to label the cells, and give the units for the measurements) and use the spreadsheet to calculate the values of *ma* and their averages. Once you have finished, make sure to print **one copy** for your report. After you have discussed them and reached conclusions, everyone in your group should answer all of the questions (written in *italics* above) separately and hand them in with the plots and data table (see Rubric).