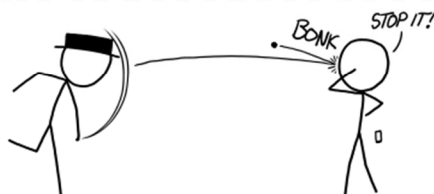


Impulse-Momentum Theorem



OBJECTIVES

Students will...

- ♥ Analyze the relationship between the impulse applied to an object and the change in the object's momentum.

MATERIALS

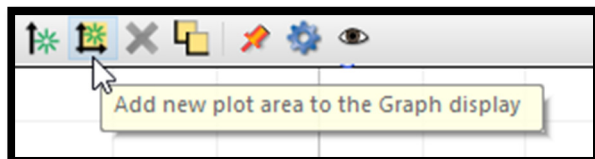
- PASCO Smart Cart with a nub attachment, track, force bracket

SAFETY

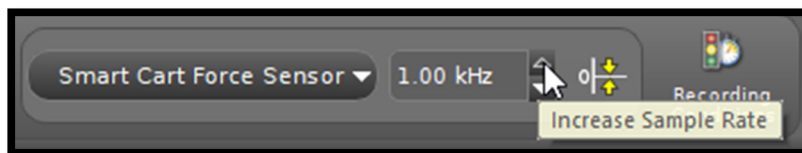
- Please follow the usual safety procedures regarding use of this equipment.

PROCEDURE:

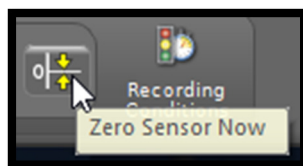
1. Set up your track with a force bracket at one end.
2. Turn on Capstone, connect your car, and pull one graph onto the screen.
3. Click the button shown below to add a second graph. (Be sure to follow this step exactly as written.)



4. Set the top graph to read Force v Time and the bottom graph to read Velocity v Time.
5. We need to increase the sample rate of the force sensor on the Smart Cart. This means that we need for the Smart Cart to take more data measurements in a given amount of time. We do this by increasing the frequency of measurements. At the bottom of your screen use the drop-down menus to select the Smart Cart Force Sensor and then click the appropriate arrow to increase the sample rate to 1.00 kHz. (This means it will take measurements 1000 times per second. It was originally set at 20 Hz, meaning it was only taking 20 measurements per second.)



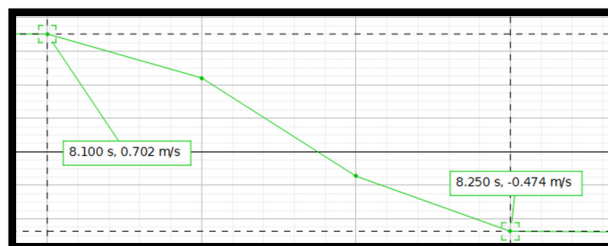
6. Click record and zero the force sensor by clicking this little gem of a button at the bottom of the screen. Then stop recording.



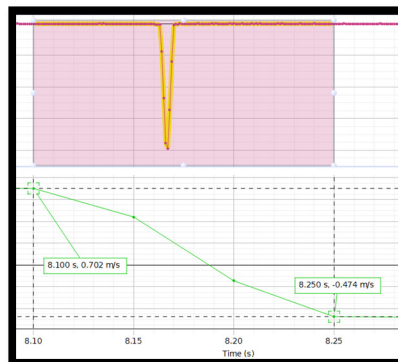
7. Place your car on the track about 20-30 cm away from the force bracket with the rubber nubby facing the bracket. **Position someone near the bracket to catch the car in case it jumps the track.** Begin recording data and give your car and confident push toward the bracket. This push should not be so hard that the car leaves the track, but it should be hard enough to get reasonably good data, such as that shown to the right.



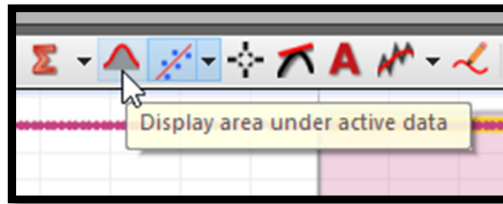
8. Zoom in so that the portion of the graph shown in step seven fills the majority of your screen.
9. Click on the Velocity vs. Time graph to activate it. Use the coordinates tool (shown below-left) to measure and record the initial velocity immediately prior to the impact and the final velocity immediately after the impact. You can turn on two coordinates tools if you'd like or just move one around on the screen. Note: Your measurements should be at similar positions to those shown in the picture below-right. Be sure to measure the very last point before the velocity starts to change and the very first point after the velocity is completely done changing. For example, notice that the two points during the transition are not measured in the image below.



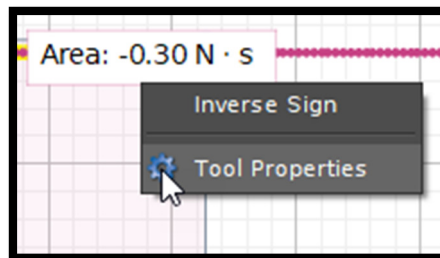
10. Next click on the Force vs. Time graph to activate it. Highlight the graph so that the highlight box lines up exactly with the times between the two points you measured in step nine. The image below shows this step correctly done.



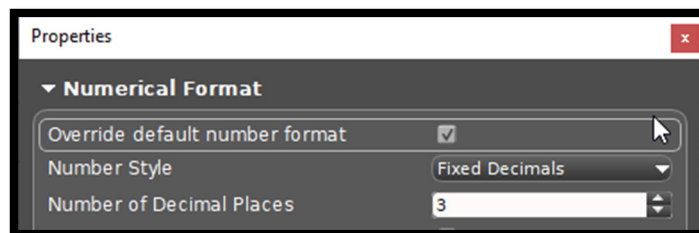
11. Now measure the area between the curve (the plotted data line) and the x-axis by selecting the button shown below.



12. We need to set the precision of the measurement so that it shows the area measured to the three digits after the decimal. To do this, right-click on the box that shows the area and select "Tool Properties."



Then click on "Numerical Properties" and check the box that reads "Override default number format." Next increase the "Number of Decimal Places" to three. Then close the dialog box.



Record the area under the curve. (Be sure to include units.) The area under the curve equals the y-axis variable multiplied by the x-axis variable. In this case that means that the area under the curve equals force x time, or Ft.

13. Everybody clap your hands.

DATA TABLES & GRAPHS

- ♥ Include the following measurements:
 - ♥ Mass of the Smart Cart
 - ♥ Initial velocity of the Smart Cart just before the collision
 - ♥ Final velocity of the Smart Cart just after the collision
 - ♥ The area under the curve of the Force vs. Time graph
- ♥ Remove all highlighting and tools, zoom so that all relevant data fills the display, and take a screenshot of the display (Display > Copy Display.) Include this screenshot in your lab report.

Continued on next page...

CALCULATIONS

- ♥ Change in momentum during the collision.
- ♥ Percent difference between the change in momentum during the collision and the impulse by using the following equation.

$$\% \textit{ difference} = \left\{ \frac{(A - B)}{\left[\frac{(A + B)}{2} \right]} \right\} \times 100$$

CONCLUSION

Analyze your data in order to draw a conclusion about the objective of the lab.