Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Smart Cart Lab: Impulse-Momentum Theorem***

Note: Screen shots of a prior run of this experiment are provided at the end of this document.

In this lab, we’ll use PASCO Smart Carts and SPARKvue software to confirm Newton’s 2nd Law of Motion.

Procedure:

1. Obtain a 1-m long track. Adjust the feet and use a bubble level to make sure the track is level.
2. Obtain a single Smart Cart. Turn it on, and make sure you see a blinking red light. This means it is blue tooth ready. Remove the magnetic “bumper” from the front of your Smart Cart and attach the hook to where the bumper had been screwed in. This hook now will be attached to the Smart Cart’s force sensor. Use a scale to determine the mass of your Smart Cart:

mCart = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Obtain a PC laptop, insert a Bluetooth adapter into a USB port, begin running SPARKvue, and connect your Smart Cart to SPARKvue.
2. Build an experiment with 3 pages. On the first page, have a data table with columns for time, force, and velocity. (You can add columns to your data table by clicking on the icon at the bottom of the page.) On the 2nd page have a graph of both force vs. time. On the 3rd page have a graph of velocity vs. time.
3. Add four 250-g masses to the top of your cart and tie a string to the force sensor hook. (You will use this string to pull the cart.)
4. Before you can take data, you need to zero-out your force sensor. Click the “Show Hardware Setup” icon. Then click the “gear” symbol next to “Smart Cart Force Sensor”. Then click “Zero Sensor Now”.
5. Place your cart on one end of the track. Click to start taking data. Grab the string tied to the hook and pull for a few moments, but stop pulling before the cart reaches the end of the track. Let the cart coast for a few moments, then stop taking data.
6. Use the data on Page 1 of your experiment to determine the time of the exact moment when the force began to be applied to the car, and the exact moment you ceased applying force to the car. Then fill out the following data table.

**Table 1**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Time (s) | Force (N) | Velocity (m/s) |
| Pulling begins |  |  |  |
| Pulling ends |  |  |  |

1. On your Force v. Time graph, click the “Lock” button in the graph tools, then click “Scale to fit”.
2. Highlight the portion of your Force v. Time graph during which you were pulling on the car. Click the “Show Statistics” button and determine the area underneath your graph.

Area = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Explain the physical meaning of this value and what its units are.
2. Calculate the change in momentum for the car before and after it was pulled. Show work below:

Δp = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. State the Impulse-Momentum Theorem, and explain what it would predict regarding your answers to #10 and #12.
2. Calculate the %-difference between your values in #10 and #12.

 %-difference = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. To what might a non-zero %-difference be attributed in this particular experiment? Please list more than one reason, and please be specific.





