

Impulse Demonstration

Equipment:

Smart Cart
Accessory Rubber Bumper

Learning Outcome:

A force acting on an object for a period of time imparts an impulse to that object which is defined as a change in momentum.

Experimental Setup:

1. Take your Smart Cart out of the box
2. Attach the rubber bumper accessory (included with Smart Cart) to the force sensor on the Smart Cart.
3. Press the power button on the side of the Smart Cart to turn it on.
4. In SPARKvue or Capstone, pair the Smart Cart to your computer or device. Here are a couple short videos to help you pair in either software:
 - a. SPARKvue: <https://www.youtube.com/watch?v=tsdHWu4quNo>
 - b. Capstone: <https://www.youtube.com/watch?v=JGy-UG245lY>
5. In the software, you will need to create a graph of Force vs. Acceleration.
 - a. In SPARKvue:
 - i. Under “Quick Start Experiments” choose: Impulse
 - ii. Increase the sampling rate of the Force sensor to 1KHz
 - b. In Capstone:
 - i. Create two graph displays
 - ii. Graph 1: [Force] vs. Time
 - iii. Graph 2: [Velocity] vs. Time
 - iv. Increase the sampling rate of the Force sensor to 1KHz

You will push the cart into a barrier such that the rubber bumper will collide and bounce the cart off the barrier. A wall, book or other solid vertical surface will work.

Data Collection:

1. Zero the force sensor
2. Press the record data button
3. With the rubber bumper facing towards the barrier, give the Smart Cart a push.
4. After the Smart Cart has reversed direction, stop data collection.

Data Analysis:

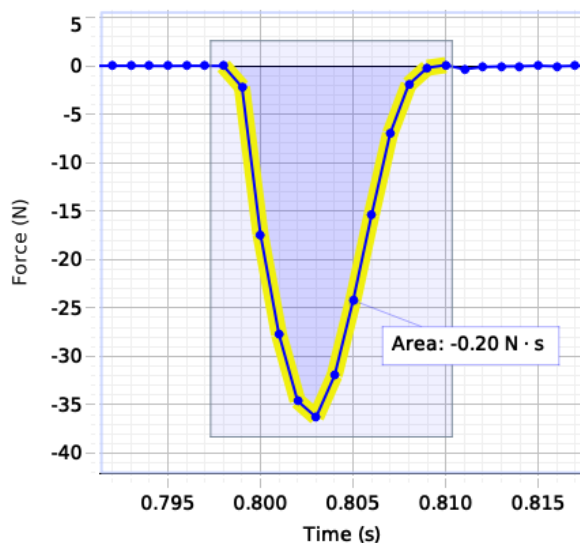
1. On the Force vs. Time graph, use the Area tool to measure the area under the curve. This is the impulse that the Smart Cart experienced.
2. On the Velocity vs. Time graph, use the Coordinate tool to find the velocity just before the impact of the Smart Cart against the barrier and record this value. This is the Smart Cart's initial velocity.
3. Next, using the Coordinate tool find the velocity after the collision with the barrier. Record this value. This is the Smart Cart's final velocity.
4. Weigh the cart without any bumper and record the mass. You may also estimate the mass of the Smart Cart to be around 0.250 kg.

Calculate the change in momentum of the Smart Cart: $p_f - p_i$

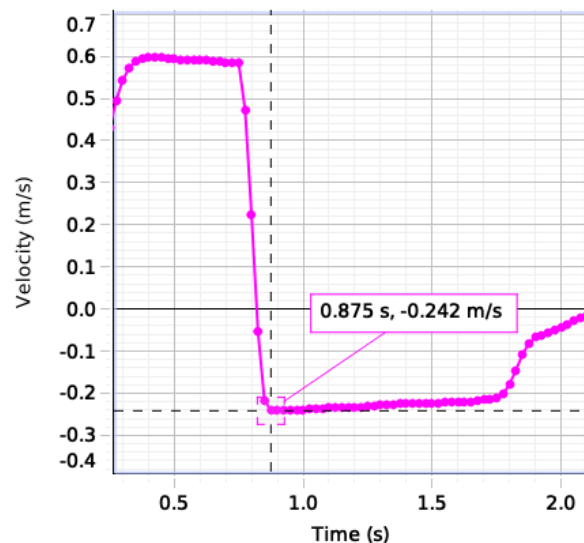
Compare your calculated value to the area under the Force vs. Time graph.

Sample Data:

This data was created with a Smart Cart that measured 0.246 kg, for an error around 1.5%.



Force vs. Time



Velocity vs. Time