**Impulse & Change in Momentum**

**with Vernier SensorCart**

(Assumes the use of Bluetooth connection to device with Graphical Analysis 4 app.)

1. Basic idea of lab:

* Put spring bumper on the force probe inside the SensorCart.
* Take rubber anti-roll peg out of the cart if using on a lab table.
* Set up monitoring of Force, Velocity and Position of the cart.
* Give cart a push across the table and have a collision with an object or hand, causing the cart to rebound in the opposite direction.

Solid object

Push

Cart w/ Spring

* Record and analyze the Force and Velocity graphs.

1. Turn Sensor Cart ON by pressing the power button. A blinking red LED will indicate that it is working.
2. Launch Graphical Analysis 4 on your device or computer. When it comes up, it will display a menu from which you will choose “Sensor Data Collection”.
3. Connect to your SensorCart, choosing it by matching the serial number. (Hint: The last four numbers or letters should be sufficient for this.)
4. Under **SENSOR CHANNELS** choose **Position** and **Force**. Note that you can get position, velocity and acceleration when you monitor “Position”.
5. Set up two graphs, one for **Force vs Time** and the other for **Velocity vs Time**.
6. Put the SensorCart in the starting position. Click/Tap on the **Position** field and **Zero** that reading. Likewise, zero the **Force**.
7. Click on the **Mode** field. **Start Collection** “On a triggering event”. Choose a position so the cart has moved about 3/4ths of the way to the bouncing position. Also set the **End Collection** to 2 seconds duration.
8. Click/Tap on “**Collect**” to begin data collection. Nothing will get collected until the cart has moved the distance you programmed above.
9. Push the cart so it collides with your solid object and bounces back. Collection will stop automatically at the end of 2 seconds.
10. Double-click or double-tap on both graphs to autoscale them.
11. Bracket the force curve generated during the bounce, noting the beginning and ending times. Make the same time bracket for the velocity graph.
12. Click/Tap on the **Graph Tools** icon for the Force graph and select **View Integral**. Note this value as the **Impulse** given to the cart..
13. Click/Tap on the **Graph Tools** icon for the velocity graph and select **View Statistics**. Determine the velocity of the cart before the bounce and after. Calculate the change in velocity and record it.
14. Theory predicts that impulse (area under the Force vs Time graph) equals the change in momentum. To get the latter, multiply the change in velocity by the mass of the SensorCart. How closely does the experiment follow theory? Repeat to verify your results.

**DATA COLLECTED**

Mass of Cart plus Spring: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Trial 1** | **Trial 2** | **Trial 3** |
| Impulse Measured |  |  |  |
| Initial Velocity |  |  |  |
| Final Velocity |  |  |  |
| Change in Velocity |  |  |  |
| Predicted Impulse |  |  |  |

How do things change if the cart is placed on an inclined plane and rolls downward, colliding with a stationary object near the bottom of the plane? How do things change if the cart is pushed up the incline before colliding?

*C. Bakken – 4/2019*