Physics 30 eLab
Momentum in an Elastic Collision

Background:

When two vehicles or objects collide, the results can be complicated. Whether it is shopping carts or cars travelling at high speed on the highway, the principle of momentum conservation can help in the analysis of these complicated collisions. In this lab, a motion sensor will be used to collide a cart into a barrier in an elastic collision. The momentum of the cart before and after collision will then be compared.

The Question:

Is momentum conserved in an elastic collision?

Variables:

This experiment involves these variables: momentum pre-collision, momentum post-collision, mass of the cart. Identify and state the manipulated, responding, and controlled variables in this investigation.

Materials:

- motion sensor
- 250 g masses
- USB link
- triple beam balance or electronic scale
- dynamics cart with magnetic
- dynamics system (if you do not have a dynamics system, you can substitute any smooth ramp)
- magnetic end stop for dynamics track

Procedure:

Step 1:

Connect the USB Link to the computer. Connect the motion sensor to the USB link. Place the motion sensor about two-thirds the way down the dynamics track. Make sure the motion sensor is set to "cart". Place the cart a short distance away from the motion sensor. At the end of the track, attach a magnetic end stop - arrange the cart on the track so that when it reaches the magnetic end stop, it will be repelled.

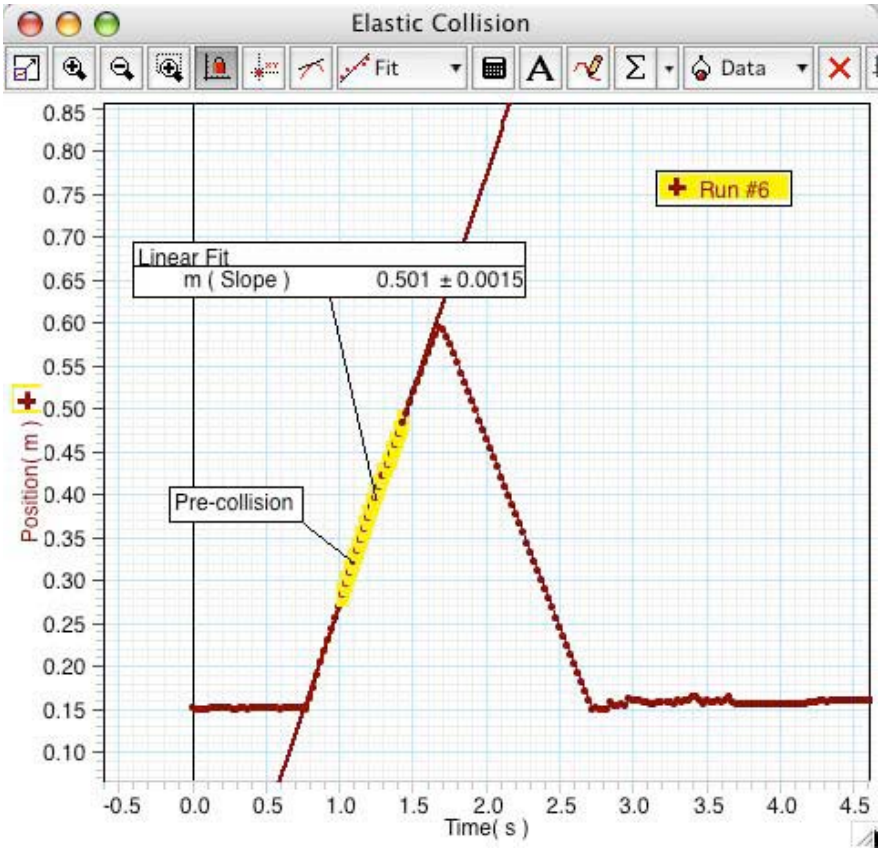
Step 2:

Configure the DataStudio software to display a position-time graph for the motion sensor. This is the default display for the sensor, so it may already be present on the computer screen. Use the setup window in DataStudio to increase the sampling rate of the motion sensor to 40 Hz. Press START in DataStudio, then propel the cart toward the magnetic end stop. Keep your hand and finger low and away from the motion sensor, so that motion sensor detects the cart's motion, and not your hand.

After the cart has collided with the end stop and is travelling back toward the motion sensor, press STOP in DataStudio. To avoid damage to the motion sensor, stop the cart before it collides with it.

Step 3:

In the position time graph, use the FIT tool to apply a linear fit to the data. You will do this twice; once for pre-collision, and once for post-collision. The pre- and post-collision areas on the graph should be easy to identify; look for a spot where the slope of the graph changes dramatically. This is where the collision with the barrier took place:



The first linear fit slope indicates the velocity of the cart pre-collision, and the second linear fit slope indicates the velocity of the cart post-collision. Record these velocities in an appropriate table. Determine the mass of the cart, and use the mass and velocity to calculate the momentum before (initial) and after (final) collision. Calculate the percentage difference between the initial and final momentum values.

Trials	Initial Velocity (m/s)	Final Velocity (m/s)	Initial Momentum (N·s)	Final Momentum (N·s)	Momentum % Difference
No addtional mass					
250 g added to the cart					
500 g added to the cart					

Step 4:

Repeat steps 2 and 3 while adding mass to the system using cart masses.

As indicated in the table above, change the mass of the cart by 250 and 500 g.

Analyzing and Interpreting:

1. How did the momentum compare before and after collision? If there was a significant difference between before and after, offer an explanation for the difference.

2. What was the effect of adding mass to the cart? Explain.

Forming Conclusions:

3. Write an answer to the following question: Is momentum conserved in an elastic collision?

Applying and Connecting:

4. Design and conduct an elastic collision that involves two dynamics carts colliding with each other.