Conservation of Momentum Lab

Introduction: The product of the mass of a moving object and its velocity is called its momentum. A bullet with a small mass and a high velocity may have the same momentum as a truck with a large mass and a very small velocity. Newton's third law of motion states that every action force is accompanied by an equal and opposite reaction force. Thus, when a rifle is fired, the force on the bullet is accompanied by an equal and opposite force on the gun which produces an equal and opposite impulse on each object. In this experiment, two carts with unequal masses will simulate the gun and the bullet. One of the carts contains a spring mechanism to provide the equal and opposite forces for the experiment. The velocities of the carts will be measured with motion detectors connected to the Lab-Pro interface and a computer.

Purpose: The purpose of this experiment is to verify the law of conservation of momentum for one-dimensional motion.

Apparatus:

Dynamics cart	Lab-Pro interface
Collision cart (or 2nd Dynamics cart)	Dynamics track
Two 500 g masses	Motion detectors
Computer with Logger Pro software	Connecting cables

Procedure:

1. Set up the dynamics track with a motion detector at each end. Make sure the track is level by placing a cart on the track. The cart should not roll in either direction. If the cart tends to roll, adjust the track with the leveling screws on either end.
2. Measure the mass of each cart and record. The carts are labeled as cart 1 and cart 2.
3. Open the Logger Pro program. Open the Physics with Vernier folder, then the Momentum, Energy and Collisions file.
4. Compress the spring of the dynamics cart and place the carts together at about the center of the track. Cart 1 should be pointed toward motion detector 1 and cart 2 towards motion detector 2. Keep this orientation in all your trials.
5. Click the *Collect* button on the computer. Using a ruler or other tool provided (not your finger), tap the plunger, releasing the spring so the carts move apart. Be careful you don't move the carts in any way or impede their motion when you tap the spring release. Keep your hands and the ruler out of the way during the motion. Be sure to catch the cart before it rolls off the open end of the track. Click the *Stop* button to stop data collection.
6. Sketch the velocity graph for the first trial and identify and label the portions of the graph that correspond to:
    a. the time when the carts were at rest before the spring was released
    b. the time the carts were moving apart
    c. the time when the carts were stopped (or too close to the motion detectors to be tracked).
7. Click and drag the mouse to highlight the region where the carts were moving apart at constant speed. Click the STATS button to find the mean (average) velocity for each cart and record in the data table. One of the velocities will be negative. Be sure you include this negative sign in the data table and the calculations.
8. For trial 2, add a 500 g mass to the collision cart (the one without the compressed spring), and repeat the procedure, recording the velocities in the data table.
9. For trial 3, repeat the procedure with two 500 g masses on the collision cart, finding the velocities of both carts as you did before.
10. Calculate the final momentum of both carts in all 3 trials and record in the data table.

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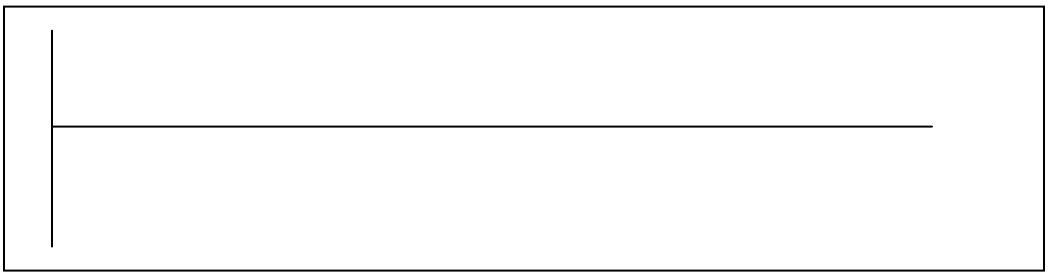

Trial 1 graph sketch

Cart 1 mass _____ Cart 2 mass _____

Data Table			
	Total Mass (kg)	Velocity (m/s)	Momentum (kg m/s)
Trial 1, Cart 1			
Trial 1, Cart 2			
Trial 2, Cart 1			
Trial 2, Cart 2			
Trial 3, Cart 1			
Trial 3, Cart 2			

Analysis and Conclusions:

1. What was the total momentum of the two carts before the spring mechanism was released ($\boldsymbol{p_i}$)? _____

2. According to the Law of Conservation of Momentum, what should the total momentum of the carts be after the release of the spring ($\boldsymbol{p_f}$)? _____

3. Calculate the total final momentum ($\boldsymbol{p_f}$) for each trial. Be sure to consider the vector nature of momentum when doing this calculation. (Remember the two carts were moving in opposite directions.)
    a. Trial 1 _____
    b. Trial 2 _____
    c. Trial 3 _____

4. Compare the total final momentum for each trial. What does the law of conservation of momentum tell us about how these quantities should be related?
    _____

5. Allowing for a small experimental error, was momentum conserved in this experiment?

    Explain. _____