Lab – Conservation of Momentum in Explosions

Materials:

- Dynamic cart with Mass
- Collision cart
- Dynamics Cart track
- Meter stick
- Mass balance

Purpose: The purpose of this experiment is to demonstrate conservation of momentum for two carts pushing away from each other.

Theory: When two carts push away from each other and no net force exists, the total momentum both carts is conserved. Because the system is initially at rest, the final momentum of the two carts must be equal in magnitude and opposite in direction so the resulting total momentum of the system is still zero.

$$p = m_1\mathbf{v}_1 - m_2\mathbf{v}_2 = 0$$

Therefore, the ratio of the final speeds of the carts is equal to the ratio of the masses of the carts.

$$v_1/v_2 = m_2/m_1$$

To simplify this experiment, the starting point for the carts at rest is chosen so that the two carts will reach the end of the track simultaneously. The speed, which is the distance divided by the time, can be determined by measuring the distance traveled since the time traveled by each cart is the same.

$$v_1/v_2 = (\Delta x_1/\Delta t)/(\Delta x_2/\Delta t) = \Delta x_1/\Delta x_2$$

Thus the ratio of the distance is equal to the ratio of the masses:

$$\Delta x_1/\Delta x_2 = m_2/m_1$$

Procedure:

1. Level the track by setting a cart on the track to see which way it rolls. Adjust the leveling feet to raise or lower the ends until a cart placed at rest on the track will not move.
2. For each of the following cases, place the two carts against each other with the plunger of the dynamics cart pushed completely in and latched in its maximum position.
3. Push the plunger release button with a short stick and watch the two carts move to the ends of the track. Experiment with different starting positions until the two carts reach their respective ends of the track at the same time. Then weigh the two carts and record the masses and the starting positions in the data table.

CASE 1: CARTS OF EQUAL MASS (use two carts without any additional mass bars)
CASE 2: CARTS OF UNEQUAL MASS (put one mass bar in one cart, none in the other)
CASE 3: CARTS OF UNEQUAL MASS (put two mass bars in one cart, none in the other)
CASE 4: CARTS OF UNEQUAL MASS (put two mass bars in one cart, one mass bar in the other)

Data:

Mass 1	Mass 2	Position	x_1	x_2	x_1/x_2	m_2/m_1

Data Analysis:

1. For each of the cases, calculate the distances traveled from the starting position to the end of the track.
2. Calculate the ratio of the distances traveled and record in the table.
3. Calculate the ratio of the masses and record in the table.

Questions:

1. Does the ratio of the distances equal the ratio of the masses in each case? In other words, is momentum conserved?
2. When carts of unequal masses push away from each other, which cart has more momentum?
3. When the carts of unequal masses push away from each other, which cart has more kinetic energy?
4. Is the starting position dependent on which cart has its plunger cocked? Why?