Name _____ Class _____ Period _____

Tailgated by a Dart

Lab 8.03

Purpose

To estimate the speed of an object by applying conservation of momentum to an inelastic and elastic collision.

Required Equipment

- Meter stick
- Stop watch

Inelastic Collision: The Theory

A ball is launched horizontally and embeds in the catcher mounted on the dynamics cart. The cart and ball then move off at a constant velocity. See Figure 3.1.

Momentum is conserved during the collision, but energy is not conserved. The momentum before the collision is equal to the momentum after the collision:

$$p_{before} = p_{after}$$

$$m_b v_o = (m_b + m_c) v_c$$

where m_b is the mass of the ball, v_o is the muzzle velocity of the ball, m_c is the mass of the catcher and cart, and v_c is the velocity of the cart and ball immediately after the collision. An inelastic collision is one in which two separate objects collide and stick together.

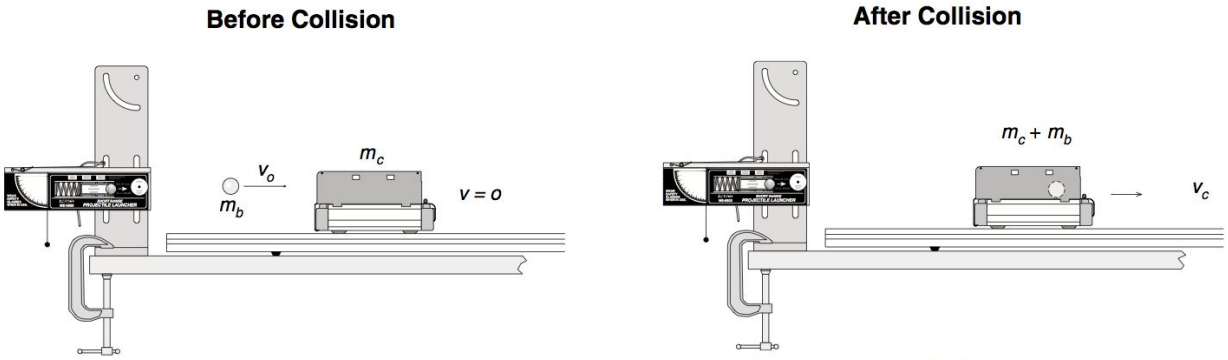
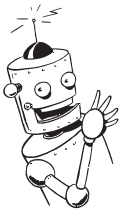


Figure 3.1: Conservation of Momentum in the Inelastic Collision

Getting Started

1. Setup a dynamic track as demonstrated by your instructor.
2. Attach a projectile launcher to one end of the track as demonstrated.
3. Obtain a dynamic cart with a catch and a steel ball from your instructor.
4. Place the cart on the track and line it up the catch with the spring gun.



5. If you are using potogates, setup two potogates so that they are spaced 0.1 m (10-cm) apart and right in front of the carts starting position.
6. Load the bullet into the spring gun. Only use the setting give by your instructor. Using the wrong setting can damage the cart and track.
7. After the bullet is loaded, place the cart against the end stop and fire the gun.
8. If you are not using photogates, immediately begin timing the cart over a 1-m costing distance. Record your results in data table A.
9. Record the mass of the cart bellow.

   Mass of cart (kg): _____

10. Record the mass of the ball bellow.

    Mass of cart (kg): _____

Data Table A

Coasting Distance (m)	Time (s)				Velocity of cart upon impact (m/s)	Initial velocity of bullet (m/s)
	trial #1	trial #2	trial #3	Ave Time		

Calculating Velocity of Cart

11. Use the formula bellow to calculate the velocity of the cart with the ball after the collision.

$$v = \frac{\Delta d}{\Delta t} \qquad v_{cart+ball} = \frac{d_{coasting}}{t_{ave}}$$

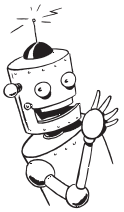
Show your work:

Calculating Initial Velocity of Bullet

12. Use the formula bellow to calculate the velocity of the cart and the ball together.

$$m_b v_o = (m_b + m_c) v_c \qquad v_b = \frac{(m_b + m_c) v_{c+b}}{m_b}$$

Show your work:



Break Apart: The Theory

Two dynamic carts are placed together and a spring plunder launches the two carts away from one another.

The momentum before the collision is equal to the momentum after the collision:

$$p_{before} = p_{after}$$

$$(m_1 + m_2)v_o = m_1 v_{1f} + m_2 v_{2f}$$

where m_1 is the mass of one car and m_2 is the second cart. v_o is the original velocity of the two carts before the break apart, and v_{1f} is the velocity of the cart 1 and v_{2f} is the velocity of car 2 after they break apart.

If the original velocity of the two carts together is zero, then the momentum of cart 1 and cart 2 will be equal to each other.

$$0 = m_1 v_{1f} + m_2 v_{2f} \qquad m_1 v_{1f} = m_2 v_{2f}$$

13. Obtain a plunger cart from your instructor.

14. Record the mass of the cart without the plunger bellow

Mass of cart 1 (kg): _____

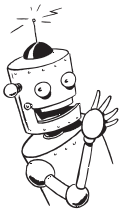
15. Place the two carts in the middle of the track with the plunger pushing on both carts.

16. Push the plunger down three clicks and lock in place.

17. When ready, release the plunger and begin timing both carts over a 1-m distance. Have one group member time cart 1 and a second group member time cart 2. Record in data table B.

Data Table A

Cart #	Coasting Distance (m)	Time (s)				Velocity after breakup (m/s)	Momentum after breakup (kg*m/s)
		trial #1	trial #2	trial #3	Ave Time		
1							
2							



Calculating Velocity each Cart

18. Calculate the momentum of each cart after they break apart and record in data table B.

$$v = \frac{\Delta d}{\Delta t} \qquad v_{cart} = \frac{d_{coasting}}{t_{ave}}$$

Calculating Momentum of Cart 1 (no plunger)

19. Momentum is mass in motion. Calculate the momentum of cart 1 after they break apart and record in data table B.

$$p = mv \qquad p_1 = m_1 v_1$$

Calculating Momentum of Cart 2 (plunger)

20. The momentum before the carts break part is zero so after the carts break apart the momentum also has to be zero. Use the equation bellow to solve for the momentum of cart 2 after they break apart and record in data table B.

$$p_i = p_f \qquad 0 = m_1 v_{1f} + m_2 v_{2f} \qquad m_1 v_{1f} = m_2 v_{2f}$$

Calculating the Mass of Cart 2 (plunger)

21. The momentum before the carts break part is zero so after the carts break apart the momentum also has to be zero. Use the equation bellow to solve for the momentum of cart 2 after they break apart.

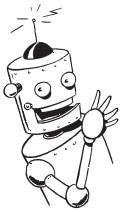
$$0 = m_1 v_{1f} + m_2 v_{2f} \qquad m_1 v_{1f} = m_2 v_{2f} \qquad m_2 = \frac{m_1 v_{1f}}{v_{2f}}$$

Mass cart 2 (kg): _____

Percent Error

22. Get the actual distance from your teacher and calculate the percent error using the percent error formula. Show all your work.

$$\%\ \text{error} = \left(\frac{\text{calculated mass} - \text{actual mass}}{\text{actual mass}} \right) \times 100$$



Percent error: _____