AP Physics 1
California Crosspoint High School
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Collisions and Momentum Lab

Objective

Predict and test the resulting motion from two objects that collide and undergo both elastic and inelastic collisions.

Procedure

1. Measure the masses of the carts and the hexagonal masses.
2. For each case, measure the initial and final velocities of the carts. To adjust for elastic and inelastic, arrange the magnets on the carts to either repel or attract.

CASE	COLLISION	CART 1		CART 2
1	ELASTIC	Blue with 4 masses	…hitting…	Blue with no masses (@ rest)
2	INELASTIC	Blue with 2 masses		Blue with 2 masses (@ rest)
3	EXPLOSION	Grey with no masses (@rest)	…explosion with…	Blue with 4 masses (@ rest)

Assignment

1. **Data Table** *Mass of 1 Hexagonal Mass*: *125g*

Mass of Blue Cart: 315g (0.315kg) Mass of Blue Cart with 2 masses: 565g (0.565kg)

Mass of Blue Cart with 4 masses: 815g (0.815kg) Mass of Grey Cart: 265g (0.265kg)

CASE	Initial Velocity of Cart 1 (m/s)	Initial Velocity of Cart 2 (m/s)	Final Velocity of Cart 1 (m/s)	Final Velocity of Cart 2 (m/s)
1	0.496	0	0.159	0.668
2	0.873	0	0.412	0.412
3	0	0	0.859	0.276

2. Calculations
   a. Calculate the theoretical final velocities of both carts in Case 1 after the collision.
   Solving using a system of equations:

$$m_1 v_1 = m_1 v_1' + m_2 v_2'$$

$$v_1 - v_2 = -(v_1' - v_2') = -v_1' + v_2'$$

$$v_2' = v_1 - v_2 + v_1'$$

$$m_1 v_1 = m_1 v_1' + m_2 (v_1 - v_2 + v_1')$$

$$v_1' = 0.2195 \frac{m}{s}$$

$$v_2' = 0.7155 \frac{m}{s}$$

b. Calculate the theoretical final velocities of both carts in Case 2 after the collision. Calculate the final momentum of both carts in Case 3. How do the two momentums compare? Explain the relationship between the two.

Case 2:
$m_1 v_1 = (m_1 + m_2)v$
$v = 0.4365 \frac{m}{s}$

Case 3:
$p = mv$
$p_1' = m_1 v_1' = 0.2276 \frac{kgm}{s}$
$p_2' = m_2 v_2' = 0.2249 \frac{kgm}{s}$
The momentums of the two carts theoretically should be the same and are around the same. The explosion releases an equal amount of energy to both carts, which means that the momentum on both sides are the same. Because Cart 2 is heavier when compared to Cart 1, the velocity would also be less.

3. Discussion Questions
   a. When two carts collide, how do the forces they exert on each other compare? How do the impulses compare?
   The forces the two carts will exert on each other are the same. This is supported by Newton's third law, which states "For every action (force) in nature there is an equal and opposite reaction." The impulses are also the same, as they have the same force and we know that $\Delta p = F\Delta t$
   b. In which cases (cases 1 through 3) should the kinetic energy be conserved?
   Cases 1
   c. In which cases (cases 1 through 3) should the momentum be conserved?
   Cases 1 and 2