

Collisions

Goals:

1. to understand the definition of momentum, especially that it is a vector.
2. To experimentally verify conservation of momentum for one-dimensional collisions.
3. To get practice determining whether or not collisions are elastic.

Part one: One-Dimensional Collisions

You will perform two different one-dimensional collisions between carts. In one collision the carts should stick together and be of different masses, and in the other they should bounce off of each other and be of like masses (this makes the mathematical prediction much easier). You will note that one end of each cart contains magnets. With the magnetic ends of two carts facing each other, the carts will bounce. If the carts do not actually collide, you will get less energy dissipation to sound and heat, and thus have an elastic collision.

Plug two motion detectors into Lab Pro (one in Sonic 1 and the other in Sonic 2). Open **Collisions** (in Physics Experiments/ 220 – 221 / Collisions). You will have one motion detector at each end of the track, if aimed properly (and set to their narrow range) each detector should only track the cart nearest to it.

Play around a little with your set-up to make sure you've got the motion detectors properly aimed to only sense one car each.

Note: Friction will drain momentum from the carts. To minimize friction's effect on your data, use velocity measurements from *immediately* before and after the collisions.

Collision #1: stick together, different masses

You'll begin with one cart sitting still and the other moving toward it.

1. Record the masses of the carts.

$$m_1 = \underline{\hspace{2cm}} \qquad m_2 = \underline{\hspace{2cm}}$$

2. Record the initial and final velocities of the carts including the signs (on the Analyze menu, select Examine).

$$v_{1o} = \underline{\hspace{2cm}} \qquad v_{2o} = \underline{\hspace{2cm}}$$

$$v_{1f} = v_{2f} = \underline{\hspace{2cm}}$$

3. **Pre-Lab:** Sketch the initial and final situations. Be sure to label the carts and indicate the directions of their velocities.

4. **Pre-Lab:** Develop an equation for the final speed of the carts, (v_f) depending only on m_1, m_2, v_{1i} , and v_{2i} .

5. Plug your measurements for the initial conditions into this equation.

$$v_{1f} = \underline{\hspace{10cm}}$$

6. How does the predicted velocity compare with that measured? (Calculate the percentage difference.) $\frac{v_{f-calc} - v_{f-measured}}{v_{f-measured}} \times 100\%$

7. How does the initial total kinetic energy compare with the final total kinetic energy? (Calculate the percentage change.) $\frac{K.E._{f-measured} - K.E._{i-measured}}{K.E._{i-measured}} \times 100\%$. Show all work.

8. How does the initial total momentum compare with the final total momentum? (Calculate the percentage change.) $\frac{\vec{p}_{f-measured} - \vec{p}_{i-measured}}{\vec{p}_{i-measured}} \times 100\%$. Show all work.

9. Was momentum conserved in the collision? Explain.

10. Was the collision elastic? Explain.

Collision #2: carts bounce apart, same mass

You will again start with one cart stationary.

11. Record the masses of the carts.

$$m_1 = \underline{\hspace{2cm}} \qquad m_2 = \underline{\hspace{2cm}}$$

12. Record the initial and final velocities of the carts including the signs (on the Analyze menu, select Examine).

$$v_{1o} = \underline{\hspace{2cm}} \qquad v_{2o} = \underline{\hspace{2cm}}$$

$$v_{1f} = \underline{\hspace{2cm}} \qquad v_{2f} = \underline{\hspace{2cm}}$$

13. **Pre-Lab:** Sketch the initial and final situations. Be sure to label the carts and indicate the directions of their velocities.

14. **Pre-Lab:** Assuming a completely elastic collision ($\Delta K.E. = 0$), develop an equation for the final speed of one of the carts, (v_{1f}) depending only on v_{1i} , and v_{2i} (not on v_{2f})
note: it would depend on the masses, but they'll cancel out if they're equal to each other.

15. Plug your measurements into this equation.

$$v_{1f} = \underline{\hspace{2cm}}$$

16. How does the predicted velocity compare with that measured? (Calculate the percentage difference.) $\frac{v_{f-calc} - v_{f-measured}}{v_{f-measured}} \times 100\%$

17. How does the initial total kinetic energy compare with the final total kinetic energy?

(Calculate the percentage change.) $\frac{K.E._{f-measured} - K.E._{i-measured}}{K.E._{i-measured}} \times 100\%$. Show all work.

18. How does the initial total momentum compare with the final total momentum? (Calculate

the percentage change.) $\frac{\vec{P}_{f-measured} - \vec{P}_{i-measured}}{\vec{P}_{i-measured}} \times 100\%$. Show all work.

19. Was momentum conserved in the collision? Explain.

20. Was the collision elastic? Explain.

Lab #6: Pre-lab

Name: _____

3. **Pre-Lab:** Sketch the initial and final situations. Be sure to label the carts and indicate the directions of their velocities.

4. **Pre-Lab:** Develop an equation for the final speed of the carts, (v_f) depending only on m_1, m_2, v_{1i} , and v_{2i} .

13. **Pre-Lab:** Sketch the initial and final situations. Be sure to label the carts and indicate the directions of their velocities.

14. **Pre-Lab:** Assuming a completely elastic collision ($\Delta K.E. = 0$), develop an equation for the final speed of one of the carts, (v_{1f}) depending only on v_{1i} , and v_{2i} (not on v_{2f})
note: it would depend on the masses, but they'll cancel out if they're equal to each other.