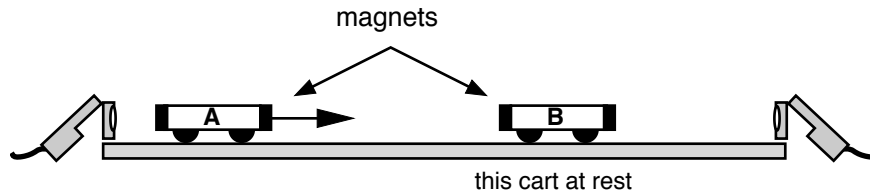


Lab 7-4: Elastic Collisions

(for the problems)

Purpose: To determine if momentum is conserved in a collision in which the two objects bounce off each other.

Materials: 1 track 2 carts with magnets in end 2 500 gram bars

Procedure:

1. Place one of the carts in the middle of the track. Place the second cart at one end of the track. Place the two motion detectors at either end of the track. (see diagram above.) Make sure that the magnets in the carts are facing each other, so that the carts bounce!
2. Start up Logger Pro and open the file "18 Momentum Energy Coll.cml".
3. Start the motion detectors and give cart A a small push so that it bounces off of cart B.
4. Record the velocity of cart A *before* the collision, and the velocities of both carts *after* the collision. Measure the velocities by first clicking anywhere on the velocity graph, and then choosing the "Examine" tool from the menu bar. Include any negative signs!
5. Place one 500 gram bar in cart B (the target cart) and repeat.
6. Place the 500 gram bar in cart A instead and repeat.
7. For the last trial, remove all the masses. Give *both* of the carts a small push so that they bounce off of each other.

Calculations:

1. For each trial, calculate the initial and final momenta of each of the carts. Show work here, and record your results in the table below.

2. For each trial, calculate the total initial momentum and the total final momentum. Show your work here, and record your results in the table below.

Data and Results:

	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Initial Momentum (kg•m/s)	Final Momentum (kg•m/s)
Cart A	0.5				
Cart B	0.5	0			
<i>Totals</i>	---	---	---		

Cart A	0.5				
Cart B	1.0	0			
<i>Totals</i>	---	---	---		

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	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Initial Momentum (kg•m/s)	Final Momentum (kg•m/s)
Cart A	1.0				
Cart B	0.5	0			
<i>Totals</i>	---	---	---		

Cart A	0.5				
Cart B	0.5				
<i>Totals</i>	---	---	---		

Conclusions:

1. In general, how did the total momentum before the carts crashed and bounced compare to the total momentum after the carts crashed?

hopefully the same!

2. One of the major ideas in science is the Law of Conservation of Momentum. What does this mean?

The total momentum before something happens is the same as the total momentum after something happened.

3. How does the conservation of momentum apply to the previous lab in which one cart crashed and stuck to a second cart?
4. How does the conservation of momentum apply to the previous lab in which the two carts both started at rest, and then pushed each other on opposite directions after the plungers were released?

$$\sum p_i = \sum p_f$$

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Questions:

1. A 1.5 kg cart moving at 3 m/s has a collision with a 3 kg cart initially at rest. The 1.5 kg moves backwards at 1.2 m/s after the collision. What is the velocity of the 3 kg cart after the collision?

$$\begin{aligned} m_1 &= 1.5 \text{ kg} & m_2 &= 3 \text{ kg} \\ v_{1i} &= 3 \text{ m/s} & v_{2i} &= 0 \text{ m/s} \\ v_{1f} &= -1.2 \text{ m/s} & v_{2f} &= ? \end{aligned}$$

$$\begin{aligned} \sum p_i &= \sum p_f \\ m_1 v_{1i} + m_2 v_{2i} &= m_1 v_{1f} + m_2 v_{2f} \\ (1.5)(3) + (3)(0) &= (1.5)(-1.2) + (3) v_{2f} \\ 4.5 &= -1.8 + 3 v_{2f} \\ 3 v_{2f} &= 6.3 & v_{2f} &= 2.1 \text{ m/s} \end{aligned}$$

2. A 200 kg bumper car has a head on collision with a 300 kg bumper car. The 200 kg car had a speed of 2.5 m/s and the 300 kg car had a speed of 1.5 m/s right before the crash. If the 200 kg car is stopped by this, what happens to the 300 kg car?

$$\begin{aligned} m_1 &= 200 \text{ kg} & m_2 &= 300 \text{ kg} \\ v_{1i} &= 2.5 \text{ m/s} & v_{2i} &= -1.5 \text{ m/s} \\ v_{1f} &= 0 \text{ m/s} & v_{2f} &= ? \end{aligned}$$

$$\begin{aligned} \sum p_i &= \sum p_f \\ m_1 v_{1i} + m_2 v_{2i} &= m_1 v_{1f} + m_2 v_{2f} \\ (200)(2.5) + (300)(-1.5) &= (200)(0) + (300) v_{2f} \\ 500 - 450 &= 0 + 300 v_{2f} & v_{2f} &= 0.167 \text{ m/s} \end{aligned}$$

means the initial velocities are opposite signs!

3. A 160 gram pool ball with an initial velocity of 3.5 m/s collides with an identical pool ball initially at rest. If the first ball continues going forward at 1.5 m/s after the collision, what is the velocity of the second ball after the collision?

$$\begin{aligned} m_1 &= 0.16 \text{ kg} & m_2 &= 0.16 \text{ kg} \\ v_{1i} &= 3.5 \text{ m/s} & v_{2i} &= 0 \text{ m/s} \\ v_{1f} &= 1.5 \text{ m/s} & v_{2f} &= ? \end{aligned}$$

$$\begin{aligned} \sum p_i &= \sum p_f \\ m_1 v_{1i} + m_2 v_{2i} &= m_1 v_{1f} + m_2 v_{2f} \\ (0.16)(3.5) + (0.16)(0) &= (0.16)(1.5) + (0.16) v_{2f} \\ 0.56 + 0 &= 0.24 + (0.16) v_{2f} \\ 0.16 v_{2f} &= 0.32 & v_{2f} &= 2 \text{ m/s} \end{aligned}$$

means they have the same mass

4. A 2 kg cart has an unknown (for now!) velocity and crashes into a 1.5 kg cart which has an initial velocity of -3 m/s. After the collision, the 1.5 kg cart has a velocity of 1.2 m/s while the 2 kg cart has a velocity of -1.7 m/s. What was the initial velocity of the 2 kg cart?

$$\begin{aligned} m_1 &= 2 \text{ kg} & m_2 &= 1.5 \text{ kg} \\ v_{1i} &= ? & v_{2i} &= -3 \text{ m/s} \\ v_{1f} &= -1.7 \text{ m/s} & v_{2f} &= 1.2 \text{ m/s} \end{aligned}$$

$$\begin{aligned} \sum p_i &= \sum p_f \\ m_1 v_{1i} + m_2 v_{2i} &= m_1 v_{1f} + m_2 v_{2f} \\ (2) v_{1i} + (1.5)(-3) &= (2)(-1.7) + (1.5)(1.2) \\ 2 v_{1i} - 4.5 &= -3.4 + 1.8 \\ 2 v_{1i} &= 2.9 \\ v_{1i} &= 1.45 \text{ m/s} \end{aligned}$$