

**eMATH****Elastic Collisions in One Dimension****Purpose:**

To explore how the final velocities of two objects are related to their masses and initial velocities when the objects collide in one dimension.

**Background:**

When two or more objects in an isolated system collide in one dimension, the momentum of the system is always conserved. Using the law of conservation of momentum, we can predict the velocities of each object immediately after collision.

The purpose of this eMATH is to calculate the velocities of two objects immediately after they collide one-dimensionally so that the relationship among mass, initial velocity, and final velocity can be determined.

**Instructions:**

- Download and open the accompanying Excel spreadsheet.

This spreadsheet will be used to calculate the final velocities of two objects immediately after a one-dimensional collision.

*For all of the calculations,  $m_2$  is initially stationary and  $m_1$  has an initial speed of 10.0 m/s.*

- Start with both objects ( $m_1$  and  $m_2$ ) each being 10.0 kg.
  - Then change  $m_1$  to 2.0 kg and press enter. The final velocities of  $m_1$  and  $m_2$  will be calculated in the spreadsheet.
  - Record the final velocities ( $\vec{v}_{1f}$  and  $\vec{v}_{2f}$ ) in the table below. Continue to calculate and record the final velocities for all values of  $m_1$  listed in the table.

Mass 1 (kg)	$v_{1f}$ (m/s)	$v_{2f}$ (m/s)
2		
4		
6		
8		
10		
12		
14		
16		
18		
20		

Mass 2 =

 $v_{1f} =$  $v_{2f} =$

**Analysis:**

1. What do all the values of  $\vec{v}_{1f}$  have in common when  $m_1$  is less than  $m_2$ ? What does this mean in terms of the direction of  $m_1$ ?
2. What is the value of  $\vec{v}_{1f}$  when  $m_1$  is equal to  $m_2$ ? What is the value of  $\vec{v}_{2f}$ ? Describe the motion of  $m_1$  and  $m_2$  in this situation.
3. What do all the values of  $\vec{v}_{1f}$  have in common when  $m_1$  is greater than  $m_2$ ? Interpret this result in terms of the motion of  $m_1$  and  $m_2$ .
4. Complete the table below using the masses and velocities given. Record the values of  $\vec{v}_{1f}$  in the second column. Make a general statement regarding the values of  $\vec{v}_{1f}$  as compared to  $\vec{v}_{1i}$ .

$m_1$ (kg)	$\vec{v}_{1f}$ (m/s)	$m_2 = 10$ kg
10		$\vec{v}_{1i} = 10$ m/s
100		
1000		$\vec{v}_{2i} = 0$ m/s
10 000		
100 000		

5. Based on this activity, make a general statement about the relationship among  $m_1$  and  $m_2$  and the final velocities,  $\vec{v}_{1f}$  and  $\vec{v}_{2f}$ .