Brady Kondek **3.05 Conservation of Momentum**

Data Collection—Table 1:

Elastic collision between equal masses

Collision 1	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**2.00**	**+3.00**	**-3.00**	**+6.00**	**-6.00**
Mass 2	**2.00**	**–3.00**	**+3.00**	**-6.00**	**+6.00**

Elastic collision between unequal masses

Collision 2	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**1.00**	**+3.00**	**-5.00**	**+3.00**	**-5.00**
Mass 2	**2.00**	**–3.00**	**+1.00**	**-6.00**	**+2.00**

Inelastic collision between equal masses

Collision 3	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**2.00**	**+3.00**	**0.00**	**+6.00**	**0.00**
Mass 2	**2.00**	**–3.00**	**0.00**	**-6.00**	**0.00**

Inelastic collision between unequal masses

Collision 4	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**1.00**	**+3.00**	**-1.00**	**+3.00**	**-1.00**
Mass 2	**2.00**	**–3.00**	**-1.00**	**-6.00**	**-2.00**

Your own elastic collision

Collision 5	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**2.00**	**+2.00**	**-2.80**	**+4.00**	**-5.60**
Mass 2	**3.00**	**-2.00**	**+1.20**	**-6.00**	**+3.60**

Your own inelastic collision

Collision 6	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**3.00**	**+2.00**	**0.00**	**+6.00**	**0.00**
Mass 2	**3.00**	**-2.00**	**0.00**	**-6.00**	**0.00**

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Total Momentum—Table 2:

Trial	Collision Type (Elastic/Inelastic?)	Total Momentum Initial (kg*m/s)	Total Momentum Final (kg*m/s)
Collision 1	Elastic	**0.00**	**0.00**
Collision 2	Elastic	**-3.00**	**-3.00**
Collision 3	Inelastic	**0.00**	**0.00**
Collision 4	Inelastic	**-3.00**	**-3.00**
Collision 5	Elastic	**-2.00**	**-2.00**
Collision 6	Inelastic	**0.00**	**0.00**

Questions and Conclusion

Answer the following questions in complete sentences.

1. Based on your observations of the six collisions, describe the physical difference between elastic and inelastic collisions.

   Elastic has to do with when two objects collide and bounce off each other. Their final velocities most likely will be different. Inelastic is when two objects collide and stick together. They will share the same final velocity in this case.

2. For which collisions was momentum conserved? Explain how you determined this using your data.

   The momentum was conserved in all of the collisions, due to "The Law of Conservation of Momentum." The quantity is conserved, neither increasing nor decreasing, and is conserved regardless of the collision type.

3. The simulation limits you to a maximum of 3 kg and +/- 3 m/s for the initial velocity. Let's imagine you want to know what would happen if the masses were higher or the balls were going faster than that. **Create** data for a trial with higher initial velocities. Make one of the final velocities 0 m/s. What would be the final velocity of the other ball? Show your work for all calculations for individual momenta and total momenta.

Collision 7	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Momentum Initial (kg*m/s)	Momentum Final (kg*m/s)
Mass 1	**2.00**	**+10.00**	**0.00**	**+20.0**	**0.00**
Mass 2	**2.00**	**-10.00**	**0.00**	**-20.0**	**0.00**

(work on next page)

Initial Momentum:

$p_{1o} = m_1 v_{1o}$
$p_{2o} = m_2 v_{2o}$
$p_{1o} =$ (2.00)(10.00) = **20.0 kg*m/s**
$p_{2o} =$ (2.00)(-10.00) = **-20.0 kg*m/s**

Final Velocity:

$p = mv \rightarrow v = \frac{p}{m}$
$v_{f1} = \frac{0.00}{2.00} =$ **0.00 m/s**
$v_{f2} = \frac{0.00}{2.00} =$ **0.00 m/s**

Final Momentum:

$p_{1f} = m_1 v_{1f}$ and $p_{2f} = m_2 v_{2f}$
$p_{1f} =$ (2.00)(0.00) = **0.00 kg*m/s** and $p_{2f} =$ (2.00)(0.00) = **0.00 kg*m/s**

Total Momentum:

Initial = $m_1 v_{1o} + m_2 v_{2o}$
Final = $m_1 v_{1f} + m_2 v_{2f}$

Initial = ((2.00)(10.00)) + ((2.00)(-10.00)) = **0.00 kg*m/s**
Final = ((2.00)(0.00)) + ((2.00)(0.00)) = **0.00 kg*m/s**

4. **Application!** Show your work as you answer the following conservation of momentum problems.
   a. A truck with mass of 3,250 kg traveling with a velocity of 25.0 m/s hits a car at rest. After the collision, the truck moves with a velocity of 19.0 m/s. The car has a mass of 2,820 kg. If the two vehicles do not stick together, how fast is the car moving after the collision?

      Given:

      $m_1 =$ 3250 kg
      $m_2 =$ 2820 kg
      $v_{1o} =$ 25.0 m/s
      $v_{2o} =$ 0.00 m/s
      $v_{1f} =$ 19.0 m/s
      $v_{2f} =$ x m/s

      Solve:

      $m_1 v_{1o} + m_2 v_{2o} = m_1 v_{1f} + m_2 v_{2f}$
      (3250 kg)(25.0 m/s) + (2820 kg)(0.00 m/s) = (3250 kg)(19.0 m/s) + (2820 kg)(x m/s)
      81250 kg*m/s = 61750 kg*m/s + 2820x kg*m/s
      19500 kg*m/s = 2820x kg*m/s
      x = 6.91 m/s

b. Two students are sitting next to each other on chairs with wheels. They push each other and separate in opposite directions. The student with a mass of 48 kg moves to the left with a velocity of 1.8 m/s. How fast and in what direction does the other student with a 59-kg mass move?

Given:

$m_1 = 48$ kg
$m_2 = 59$ kg
$v_o = 0.0$ m/s
$v_{1f} = 1.8$ m/s
$v_{2f} = $ x m/s

Solve:

$(m_1 + m_2)v_o = m_1 v_{1f} + m_2 v_{2f}$
(48 kg + 59 kg)(0.0 m/s) = (48 kg)(1.8 m/s) + (59 kg)(x m/s)
0 kg*m/s = 86.4 kg*m/s + 59x kg*m/s
-59x kg*m/s = 86.4 kg*m/s
x = -1.46 → -1.5 m/s
The student is moving -1.5 m/s after the separation. Due to moving in the opposite direction from the other student, the velocity is negative.