Exploring Elastic Collisions with Physics

Corresponding Material
Lesson 6: Elastic Collisions

Discussion
Mathematical equations can be used to solve for the mass and speed of objects in collisions. The following equations can be helpful in solving collisions problems:

Conservation of Momentum:

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

Conservation of Kinetic Energy:

$$\tfrac{1}{2} m_1 (v_{1i}^2) + \tfrac{1}{2} m_2 (v_{2i}^2) = \tfrac{1}{2} m_1 (v_{1f}^2) + \tfrac{1}{2} m_2 (v_{2f}^2)$$

These equations can be used together to solve for the final speed values:

$$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)} v_{1i} + \frac{(2m_2)}{(m_1 + m_2)} v_{2i} \qquad v_{2f} = \frac{(2m_1)}{(m_1 + m_2)} v_{1i} + \frac{(m_2 - m_1)}{(m_1 + m_2)} v_{2i}$$

Exercise
Answer the following questions after creating your elastic collision simulation.

1. Using the initial speeds, final speeds, and mass values given below, prove that the total momentum in the system is constant before and after the collision.

massOne = 50 massTwo = 50 initialSpeedOne=2 initialSpeedTwo = -2

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

2. Using the initial speeds, final speeds, and mass values given below, prove that the total kinetic energy in the system is constant before and after the collision.

massOne = 50 massTwo = 50 initialSpeedOne=2 initialSpeedTwo = -2

$$\tfrac{1}{2} m_1(v_{1i}^2) + \tfrac{1}{2} m_2(v_{2i}^2) = \tfrac{1}{2} m_1(v_{1f}^2) + \tfrac{1}{2} m_2(v_{2f}^2)$$

3. Use the combined conservation of momentum and conservation of kinetic energy equations to calculate the final speed of objectOne and objectTwo.

massOne = 50 massTwo = 30 initialSpeedOne=2 initialSpeedTwo = -2

$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)} v_{1i} + \frac{(2m_2)}{(m_1 + m_2)} v_{2i}$	$v_{2f} = \frac{(2m_1)}{(m_1 + m_2)} v_{1i} + \frac{(m_2 - m_1)}{(m_1 + m_2)} v_{2i}$

4. Use the combined conservation of momentum and conservation of kinetic energy equations to calculate the final speed of objectOne and objectTwo.

massOne = 50 massTwo = 50 initialSpeedOne=1 initialSpeedTwo = -2

$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)} v_{1i} + \frac{(2m_2)}{(m_1 + m_2)} v_{2i}$	$v_{2f} = \frac{(2m_1)}{(m_1 + m_2)} v_{1i} + \frac{(m_2 - m_1)}{(m_1 + m_2)} v_{2i}$

5. Use the combined conservation of momentum and conservation of kinetic energy equations to calculate the final speed of objectOne and objectTwo.

massOne = 50 massTwo = 30 initialSpeedOne=1 initialSpeedTwo = -2

$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)} v_{1i} + \frac{(2m_2)}{(m_1 + m_2)} v_{2i}$	$v_{2f} = \frac{(2m_1)}{(m_1 + m_2)} v_{1i} + \frac{(m_2 - m_1)}{(m_1 + m_2)} v_{2i}$

Conclusion Questions

1. How does the mass of an object affect its own final speed after collision?

2. How does the initial speed of an object affect its own final speed after collision?

3. How does the mass of an object affect the collided object's final speed after collision?

4. How does the initial speed of an object affect the collided object's final speed after collision?