8.3: Collisions

Alex L.

October 22, 2024

Definition: (Elastic Collision) An **elastic collision** is a collision where total kinetic energy is conserved. An example might be two pool balls striking each other.

Definition: (Inelastic Collision) An **inelastic collision** is a collision where total kinetic energy is not conserved. An example might be shooting a bullet into a block of wood.

In both situations, if there are no external forces, then momentum is conserved.

Proposition: (Completely Inelastic Collisions) In a **completely inelastic collision**, the velocity of the two bodies after the collision is exactly the same:

$$v_{A1} = v_{B1} = v_1$$

Additionally, conservation of momentum states that

$$m_A v_{A0} + m_B v_{B0} = m_A v_{A1} + m_B v_{B1}$$

And substituting in the prior equation, we get

$$m_A v_{A0} + m_b v_{B0} = (m_A + m_B)(v_1)$$

Example: (Ballistic Pendulum) A bullet of mass m_B makes a completely inelastic collision with a suspended block of wood with mass m_W. After the impact, the block swings to a height of h. What is the velocity of the bullet v_0 in terms of h, m_B, and m_W?

Solution: Because this is an inelastic collision, lets define v_1 to be the velocity of the bullet and block right after collision. Then,

$$m_B v_0 = (m_B + m_W)v_1$$

And solving for v_0, we get

$$v_0 = \frac{(m_B + m_W)v_1}{m_B}$$

The kinetic energy of the system right after collision is

$$K_1 = \frac{1}{2}(m_B + M_W)v_1^2 = (m_B + m_W)gh$$

since all the energy will be transformed into potential energy. Then, solving, we get

$$v_1 = \sqrt{2gh}$$

and substituting into our original equation, we get

$$v_0 = \frac{(m_B + m_W)\sqrt{2gh}}{m_B}$$