Conservation on Momentum

• In the absence of an external force the momentum of a closed system is conserved.
  – REVIEW- Closed System: system that has no gain nor loss of mass
Law of Conservation of Momentum

In a closed system, the vector sum of the momenta before and after an impact must be equal.

Before \[ m_1 v_{1i} + m_2 v_{2i} \]

After \[ m_1 v_{1f} + m_2 v_{2f} \]
A stationary firecracker explodes. What is the total momentum of the pieces that it breaks into?
Collisions

- **Elastic** - a collision in which objects collide and bounce apart with no energy loss (Kinetic Energy is conserved)
- **Inelastic** - a collision in which objects collide and some mechanical energy is transformed into heat energy (Kinetic Energy is not conserved)
  - Deformed objects
  - Objects stick together
- **Note**: Momentum is conserved in both types of collisions.
Collisions

• Elastic Collision Equation -
  \[ m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f} \]

• Inelastic Collision Equation
  – If Start Together
    \[ (m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f} \]
  – If End Together
    \[ m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f \]
Example: Recoiling Cannon
Example 1: Recoiling Cannon

A cannon of mass 750kg shoots a cannon ball of mass 30kg with a velocity of 20m/s. Find the recoil velocity of the cannon.

\[ m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2' \]

Answer: -0.8m/s
Example 2: Inelastic Collision

• A bullet of mass 0.010kg is shot at a speed of 30m/s towards a 5kg stationary block. The bullet becomes embedded in the block and the two fly off together.

• Find the speed with which they fly off.

Answer: 0.06m/s
Problem 3

• A 45 kg student is riding on a 7kg skateboard with a velocity of +4m/s. The student jumps of the cart with a velocity of -1m/s. Find the velocity of the skateboard after the student jumped off.

• Answer: +36m/s