Momentum Conservation Equations

Apply these equations when solving momentum conservation problems. Remember to first solve the equations algebraically then substitute numerical values. Be careful when entering velocity values. Velocity is a vector and can be either positive or negative depending on the reference direction and the direction of motion!

1. Objects: Before (separate and moving) – After (separate and moving)

$$m_1 v_1 + m_2 v_2 = m_1 v'_1 + m_2 v'_2$$

2. Objects: Before (together and at rest) – After (separate and moving)

$$0 = m_1 v'_1 + m_2 v'_2$$

3. Objects: Before (separate and moving) – After (together and moving)

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$$

4. Objects: Before (together and moving) – After (moving and separate)

$$(m_1 + m_2) v = m_1 v'_1 + m_2 v'_2$$

5. Objects: Before (separate and moving) – After (together and at rest)

$$m_1 v_1 + m_2 v_2 = 0$$

Collision Types

Momentum is always transferred during any collision

Inelastic Collision: Total Momentum is conserved
Kinetic Energy is not conserved
Kinetic energy may increase or decrease depending on the collision)

Elastic Collision: Total Momentum is conserved
Kinetic Energy is conserved

In addition to the momentum conservation, the kinetic energy conservation equation is also valid for elastic collision types.

$$KE_{1(\text{initial})} + KE_{2(\text{initial})} = KE_{1(\text{final})} + KE_{2(\text{final})}$$

Remember that when an object's velocity is 0 its KE is 0. The form of this equation will match the form of the momentum conservation equations above depending on the arrangement of the objects before and after the collision.