Experiment No: M2

Experiment Name: *"The Conservation of Momentum and Kinetik Energy in Collisions"*

Objective:

-Experimental investigation of the conservation of momentum and energy in elastic and inelastic collisions.

-To investigate examination of the relationship between energy and momentum.

Keywords:

Momentum, Energy, elastic collisions, inelastic collisions

Theoretical Information :

The principle of conservation of momentum derives from Newton's second law. If the net external force applied to a system is zero, it means that the momentum of the system is constant with respect to time.

$$F_{ext} = \frac{\Delta p}{\Delta t} \qquad (1)$$

F_{net}, Net external force acting on the system.

p, Momentum of the system.

When $F_{ext} = 0, \frac{\Delta p}{\Delta t} = 0$

$\Delta p = 0$ and $p = constant$

The total energy of a system is the sum of the kinetic and potential energies of the system at any instant.

$$E = K + P \qquad (2)$$

given by equality, where K represents kinetic energy and P represents potential energy.

If only conservative forces do work in a system, there is neither a decrease nor an increase in the total energy of the system. The total energy of the system remains constant (Law of Conservation of Energy).

If momentum and kinetic energy are conserved in the collision of two bodies that are not under the influence of an external force, this type of collision is called an elastic collision. A collision in which momentum is conserved and kinetic energy is not conserved is called an inelastic collision.

Elastic Collision

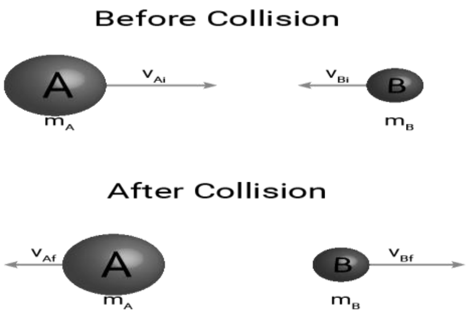

Figure 1: *Two objects before and after an elastic collision*

Before the elastic collision of two bodies with masses m_A and m_B with velocities v_{Ai} and v_{Bi}, after the elastic collision the velocities of these masses be v_{Af} and v_{Bf}. Here,i represents initial, and f represents final.

Momentum is conserved in this collision.

$$m_A v_{Ai} + m_B v_{Bi} = m_A v_{Af} + m_B v_{Bf} \qquad (3)$$

In an elastic collision, kinetic energy is also conserved. The conservation of kinetic energy is given by the equation below.

$$K_i = \frac{1}{2} m_A v_{Ai}^2 + \frac{1}{2} m_B v_{Bi}^2 \qquad (4)$$

$$K_f = \frac{1}{2} m_A v_{Af}^2 + \frac{1}{2} m_B v_{Bf}^2 \qquad (5)$$

$$K_i = K_f \qquad (6)$$

$$\frac{1}{2} m_A v_{Ai}^2 \frac{1}{2} m_B v_{Bi}^2 = \frac{1}{2} m_A v_{Af}^2 \frac{1}{2} m_B v_{Bf}^2 (7)$$

There exists a relationship between energy and momentum as shown below.

$$K_i = \frac{p_{Ai}^2}{2m_A} + \frac{p_{Bi}^2}{2m_B} \qquad (8)$$

$$K_f = \frac{p_{Af}^2}{2m_A} + \frac{p_{Bf}^2}{2m_B} \qquad (9)$$

Inelastic Collision

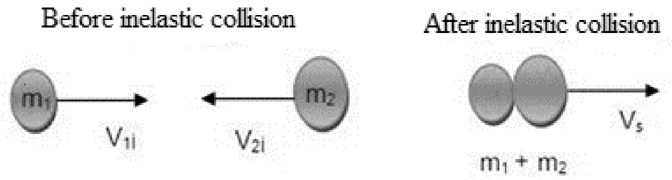

Figure 2: *Two objects before and after an inelastic collision*

Before the inelastic collision of two bodies with masses m_1 and m_2 with velocities v_{1i} and v_{2i}, after the inelastic collision the velocities of these masses be v_s. Here,i represents initial, and s represents final.

In inelastic collisions, there is a loss of kinetic energy.

The kinetic energy before the collision is K_i and the kinetic energy after the collision is K_f, $K_i > K_f$.

$$K_i = \frac{1}{2} m_1 v_{1i}^2 \frac{1}{2} m_2 v_{2i}^2 \qquad (10)$$

$$K_f = \frac{1}{2}(m_1 + m_2) v_{Sf}^2 \qquad (11)$$

The total kinetic energy difference is either converted into heat energy or stored as potential energy in the colliding bodies.

There exists a relationship between energy and momentum as shown below.

$$K_i = \frac{p_{1i}^2}{2m_1} + \frac{p_{2i}^2}{2m_2} \qquad (12)$$

$$K_f = \frac{p_{12f}^2}{2(m_1 + m_2)} \qquad (13)$$

Here, $p_{12f} = (m_1 + m_2) v_s$