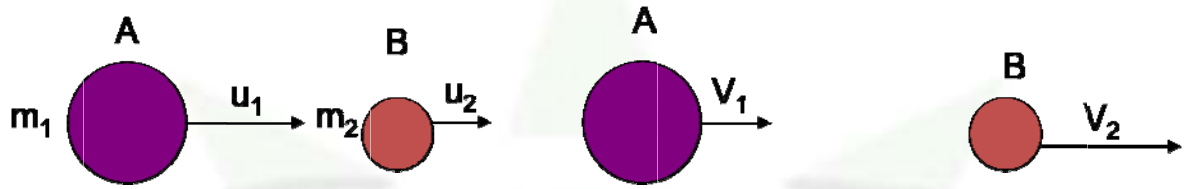
Collision

Collision: When one body collides with another the collision can be divided into two

(1) Elastic collision

(2) In elastic collision

Elastic Collision: When two bodies collide in such a way that the total linear momentum of the system and the total K.E of the system both remain conserved the collision is said to be elastic. Generally in elastic collision the colliding bodies get separated after collision.



Two bodies A & B of mass m1 and m2 are moving with velocities u_1 & u_2 ($u_1>u_2$) respectively along the same direction. After collision let A & B move with velocities v_1 and v_2 respectively ($v_1<v_2$) in the same direction as before collision.

Since linear momentum is conserved

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$
$$m_1(u_1 - v_1) = m_2(v_2 - u_2) \longrightarrow (1)$$

Since the collision is elastic Kinetic Energy is also conserved

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$
$$m_1(u_1^2 - v_1^2) = m_2(v_2^2 - u_2^2)$$
$$m_1(u_1 - v_1)(u_1 + v_1) = m_2(v_2 - u_2)(v_2 + u_2) \longrightarrow (2)$$

Putting equation (1) in equation (2)

$$(u_1 + v_1) = (v_2 + u_2)$$
$$v_2 = (u_1 - u_2) + v_1 \longrightarrow (3)$$

Putting equation (3) in equation (1)

$$m_1(u_1 - v_1) = m_2(u_1 - u_2 + v_1 - u_2)$$
$$v_1(-m_1 - m_2) = (m_2 - m_1)u_1 - 2m_2u_2$$
$$v_1 = \frac{(m_1 - m_2)}{(m_1 + m_2)}u_1 + \frac{2m_2}{(m_1 + m_2)}u_2 \longrightarrow (4)$$

Putting equation (4) in equation (3)

$$v_2 = (u_1 - u_2) + \frac{(m_1 - m_2)}{(m_1 + m_2)} u_1 + \frac{2m_2}{(m_1 + m_2)} u_2$$

$$v_2 = \frac{2m_1}{(m_1 + m_2)} u_1 + \frac{(m_2 - m_1)}{(m_1 + m_2)} u_2 \longrightarrow (5)$$

From equation (4) and (5) we can find velocities of bodies after collision.

Special cases: A ball suffers elastic collision with a wall.

u_1 = velocity of the ball before collision

$u_2 = 0$ = velocity of the wall

v_1 =Velocity of the ball after collision

Mass of the ball is negligible compared to the mass of the wall ($m_1 << m_2$)

From equation (4):

$$v_1 = \frac{(m_1 - m_2)}{(m_1 + m_2)} u_1 + \frac{2m_2}{(m_1 + m_2)} \times 0$$

$$v_1 = -\frac{m_2}{m_2} u_1$$

$$v_1 = -u_1$$

Thus velocity after collision is opposite in direction to that of before collision and the ball rebounds with the magnitude of velocity unchanged.

Inelastic Collision: The collision in which only the linear momentum is conserved but K.E is not conserved is said to be inelastic collision. Generally in inelastic collision the colliding bodies stick together after collision.