Newton's Law of collision of elastic bodies

It states that the velocity of seperation of the two moving bodies which collide with each other bears a constant ratio ~~bodies~~ to their velocity of approach. The constant of proportionality is known as the coefficient of restitution (e).

→ Direct impact

Let u_1, and u_2 velocity of body A and B before collision, v_1 and v_2 velocity of body A and B after collision. The body A will collide with body B if velocity of A is more than that of B. ($u_1 > u_2$).

velocity of approach. (Relative velocity of colliding bodies before impact]

$= u_1 - u_2$

After collision the seperation of two bodies will take place if final velocity of B is more than that of A

i.e, $v_2 > v_1$

∴ velocity of seperation (R.V of colliding bodies after impact] $= v_2 - v_1$

According to Newton's law of collision of elastic bodies

velocity of seperation ∝ velocity of approach

$(v_2 - v_1) = e\,[u_1 - u_2]$

i.e $e = \dfrac{v_2 - v_1}{u_1 - u_2}$

where 'e' is the constant of proportionality and is known as coefficient of restitution.

Coefficient restitution is defined as the ratio of velocity of seperation of the two moving bodies which collide with each other to their velocity of approach.

It is also defined as the ratio of the relative velocities of colliding bodies after impact to their R.Vs before impact.

The relative velocities are measured along the line of impact which is the common normal to the colliding surfaces.

- For most bodies the value of 'e' lies between '0' and '1'.
- For perfectly elastic bodies, e = 1
- For perfectly plastic bodies, e = 0.

Indirect Impact

Newton's law of collision of elastic bodies holds good for indirect impact.

velocity of restitution ∝ velocity of approach.

i.e. v

For the two bodies moving in the opposite direction the velocity of approach or seperation is the sum of their velocities. whereas the velocity of approach or seperation is the difference of their velocities when they are moving in the same direction before or after impact.

1. Ball A of mass 1kg moving with a velocity of .2 m/s strikes directly on a ball B of mass 2kg at rest. the ball A after striking comes to rest. Find the velocity of ball B after striking and coeff. of restitution.

$m_1 = 1kg \quad m_2 = 2kg.$

$u_1 = 2m/s \quad u_2 = 0.$

$v_1 = 0 \quad v_2 = ?$

According to the law of conservation of momentum.

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2.$$

$$1 \times 2 = 2 \times v_2$$

$$v_2 = 1 \text{ m/s}$$

$$e = \frac{v_2 - v_1}{u_1 - u_2} = \frac{1-0}{2-0} = 0.5$$