

Impulse and Momentum

LINEAR MOMENTUM of a body = (mass of body) x (velocity of body)

Momentum is a vector quantity whose direction is that of velocity and the unit is kg m /s.


IMPULSE = (force) x (length force acts) = Ft

Impulse is a vector quantity whose direction is that of force. The units are N s.

AN IMPULSE CAUSES A CHANGE IN MOMENTUM : The change of momentum produced by an impulse is equal to the impulse in both magnitude and direction. Thus, a constant F acting for t(time) on a body of mass m changes its velocity from initial v_i to final v_f .

Impulse = change in momentum

$$Ft = m (v_f - v_i)$$

CONSERVATION OF LINEAR MOMENTUM : If the resultant external force on a system of objects is zero, then the vector sum  the momenta will remain constant.

IN COLLISIONS AND EXPLOSIONS : the vector sum of the momenta just before the event equals the vector sum of the momenta just after the event. The vector sum of the momenta of the objects involved does not change during the collision or explosion.

Thus when two bodies of mass m and mass m collide,
total momentum before = total momentum after

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

where u_1 and u_2 are the velocities before and v_1 and v_2 are the velocities after - or in component form


$$m_1 u_{1x} + m_2 u_{2x} = m_1 v_{1x} + m_2 v_{2x}$$

and similarly for the y & z component!

A PERFECTLY ELASTIC COLLISION: is one in which the sum of the translational kinetic energy of the objects is not changed during the collision. In the case if two bodies, one has

$$KE = KE$$

$$\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

COEFFICIENT OF RESTITUTION : For any collision between two bodies in which the bodies move only along a single straight , a coefficient of restitution, e , is defined. It is a pure number.

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

where u_1 u_2 = velocity before and v_1 v_2 = velocity after

Notice that $u_1 - u_2$ is the relative velocity of approach and $v_2 - v_1$

is the relative velocity of recession. For a **perfectly elastic** collision $e = 1$. For **inelastic collisions** $e < 1$. If the bodies **stick together** after collision $e = 0$.