BRAIN MAP

CLASS XI

WORK, ENERGY AND POWER

WORK

Work is said to be done whenever a force acts on a body and the body moves through some distance.

$W = \vec{F}\cdot\vec{S} = FS\cos\theta$ (where θ is the angle between force applied $\vec{F}$ and displacement vector $\vec{S}$.)

The SI unit of work is joule (J).

Nature of Work Done

If $\theta = 0°$, $W = FS$ *i.e.*, work done is maximum.

If $\theta = 90°$, $W = 0$ *i.e.*, work done is zero.

Work Done by a Variable Force

The work done by a variable force in changing the displacement from S_1 to S_2 is $W = \int_{S_1}^{S_2} \vec{F}\cdot d\vec{S}$ = Area under the force-displacement graph

ENERGY

It is defined as the ability of a body to do work. It is measured by the amount of work that a body can do. The unit of energy used at the atomic level is electron volt (eV) and SI unit is J.

Kinetic Energy

It is the energy possessed by a body by virtue of its motion. The K.E. of a body of mass m moving with speed v is

$$K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$

Potential Energy

It is the energy possessed by a body by virtue of its position (in a field) or configuration (shape or size). For a conservative force in one dimension, the potential energy function $U(x)$ may be defined as

$$F(x) = -\frac{dU(x)}{dx} \text{ or } \Delta U = U_f - U_i = -\int_{x_i}^{x_f} F(x)dx$$

Power

The rate of doing work is called power.

Average Power:

It is defined as the ratio of the small amount of work done W to the time taken t to perform the work.

$$P = \frac{W}{t}$$

The SI unit of power is watt (W).

Work Energy Theorem

The work done by the net force acting on a body is equal to the change in kinetic energy of the body.

W = Change in kinetic energy

$$= \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \Rightarrow W = \Delta K.E.$$

The work energy theorem may be regarded as the scalar form of Newton's second law of motion.

Potential Energy of a Spring

According to Hooke's law, when a spring is stretched through a distance x, the restoring force F is such that

$F \propto x$ (where k is the spring constant

or $F = -kx$ and its unit is N m^{-1}.)

The work done is stored as potential energy U of the spring.

$$W = \int_0^x kx\,dx = \frac{1}{2}kx^2 \Rightarrow U = \frac{1}{2}kx^2$$

COLLISION

A collision between two bodies is said to occur if either they physically collide against each other or the path of the motion of one body is influenced by the other.

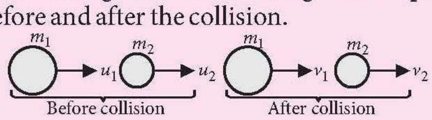
Types of Collision

Elastic collision : Both the momentum and kinetic energy of the system remain conserved.

Inelastic collision : Only the momentum of the system is conserved but kinetic energy is not conserved.

Head-on Collision or One-Dimensional Collision

It is a collision in which the colliding bodies move along the same straight line path before and after the collision.



Velocity of approach = Velocity of separation or $u_1 - u_2 = v_2 - v_1$

Also, $v_1 = \frac{m_1 - m_2}{m_1 + m_2}\cdot u_1 + \frac{2m_2}{m_1 + m_2}\cdot u_2$ and

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

Oblique Collision

If the two bodies do not move along the same straight line path before and after the collision, the collision is said to be oblique collision.