WORK

In Physics, work refers to 'mechanical work'. Work is said to be done by a force on a body when the body is actually displaced through some distance in the direction of the applied force. However, when there is no displacement in the direction of the applied force, there is no work done, i.e., work done is zero, when displacement of the body in the direction of the force is zero.

Consider a constant force 'F' acting on a body to produce a displacement 's' in the body along the positive x-direction as and if θ is the angle which F makes with the positive x-direction of the displacement, then the component of F in the direction of displacement is given by $F\cos\theta$. Since the work done by the force is the product of component of force in the direction of the displacement and the magnitude of the displacement, we can write: $W = (F\cos\theta)s$

Work is a scalar quantity. It has only magnitude and no direction. Its SI unit is joule (J). One joule of work is said to be done on an object when a force of 1 N displaces the object by 1 m along the line of action of force.

Concepts of Positive and Negative Work

- When angle between the force and displacement is acute i.e. $0° < \vartheta < 90°$ The work done is positive.
- When angle between the force and displacement is obtuse i.e. $90° < \vartheta < 180°$ The work done is negative.
- Whenever force is in the direction of motion, velocity of the object increases and work done is positive.
- Whenever force opposes motion, velocity of object decreases and the work done is negative.
- Work is positive when force and displacement are parallel to each other and that are in the same direction and work is negative when force and displacement are antiparallel to each other.
- **Condition for Zero Work**

Condition for Zero work	**Calculation of Work Done**
The net force should be equal to zero	$W = Fs\cos\vartheta = 0 \times s \times \cos\vartheta = 0$
The net displacement should be equal to zero	$W = Fs\cos\vartheta = F \times 0 \times \cos\vartheta = 0$
The force and displacement should be perpendicular to each other	$W = Fs\cos\vartheta = F \times s \times \cos 90° = 0$

When we kick a football lying on the ground, the force of our kick moves the football. Here direction of force applied & motion of football is same so work done is positive. But when football slows due to force of friction acting in a direction opposite to direction of motion of football, thus work done is negative.

The moon moves around the earth in circular path. Here force of gravitation acts on the moon at right angles to the direction of motion of the moon. So work done is zero.

Power

Power of a person or machine refers to the time rate at which work is done by it. Mathematically, Power = Rate of doing work = work done/ time taken Thus, power of a body measures how fast it can do the work. $\Rightarrow$ P = dW /dt. Now, it is known that dW=F.ds ; $\Rightarrow$ P = F.ds/ dt But v = ds/ dt, which is the instantaneous velocity. $\Rightarrow$ P = F.v

The absolute unit of power in SI system of units is watt, which is denoted by W.

Power of a body is said to be one watt, when it can do one joule of work in one second. A bigger unit if power is horsepower (hp), given by 1hp =746W

Energy

Energy of a body refers to the capacity or ability of the body to do work.

KINETIC ENERGY :The kinetic energy of a body refers to the energy possessed by the body by virtue of its motion. Here are some examples: a) A bullet fired from a gun can pierces through a target on account of kinetic energy of the bullet. b) Wind mills work on the kinetic energy of air. For instance, sailing ships use the kinetic energy of wind. c) Water mills work on the kinetic energy of water. For instance, fast flowing streams are utilized to grind corn. d) A nail is driven into a wooden block on account of kinetic energy of the hammer striking the nail.

Some more examples of kinetic energy → A moving cricket ball → Running water → A moving bullet → Flowing wind → A moving car → A running athelete → A rolling stone.

The energy possessed by a body on account of its motion is known as kinetic energy. Kinetic energy possessed by a body of mass ‘m’ moving with a velocity ‘v’ is given by the formula:

Kinetic Energy = 1 /2mv ^{2} . Kinetic energy of a body is directly proportional to the mass of the body and the square of the velocity of the body.

The potential energy of a body refers to the energy possessed by the body by virtue of its position or configuration in some field. Thus, potential energy is the energy that can be associated with the configuration (or arrangement) of a system of objects that exert forces on one another. Obviously, if configuration of the system changes, then its potential energy changes. Two important types of potential energy are: a) Gravitational potential energy b) Elastic potential energy.

Gravitational potential energy of a body refers to the energy possessed by the body by virtue of its position above the surface of the earth. Potential energy of a body of mass ‘m’ raised to a height ‘h’ above the surface of the Earth is given by the formula: Potential Energy = m g h where ‘g’ is the acceleration due to gravity.

To calculate gravitational potential energy, suppose m = mass of a body g = acceleration due to gravity on the surface of earth. h = height through which the body is raised.

If we assume that height 'h' is not too large and the value of 'g' is practically constant over this height, then the force applied just to overcome gravitational attraction is given by, F = mg. As the distance moved is in the direction of the force applied, work can be expressed as: Work done = force × distance $\Rightarrow$ W = F X h =mgh Notice that we have taken the upward direction to be positive. Therefore, work done by applied force = +mgh . However, work done by gravitational force = −mgh This work gets stored as potential energy. The gravitational potential energy of a body, as a function of height (h) is denoted by V(h), and it is negative of work done by the gravitational force in raising the body to that height. $\Rightarrow$ Gravitational PE = V(h) = mgh.

Potential energy of a spring refers to the energy associated with the state of compression or expansion of an elastic spring.

The Law of Conservation of Energy
According to the law of conservation of energy, the total energy of an isolated system does not change. Energy may be transformed from one form to another but the total energy of an isolated system remains constant.

Equivalence of Mass and Energy
According to Einstein, mass and energy are inter-convertible. That is, mass can be converted into energy and energy can be converted into mass.

The commercial unit of energy is kilowatt hour (kWh). One kilowatt hour is the amount of electrical energy consumed when an electrical appliance with a power rating of 1 kilowatt is used for 1 hour. 1 kWh is equal to 3.6×10^6 J of energy. 1 kilowatt hour of electrical energy is commonly known as 1 unit.