Marwari college Darbhanga

Subject---physics

Class--- I.Sc. first year

Topic--- Energy and power

Lacture series---+ 05

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power

The time rate of work done by a body is called its power.

Power = Rate of doing work = Work done / Time taken

If under a constant force F a body is displaced through a distance s in time t, the power
$p = W / t = F * s / t$

But $s / t = v$; uniform velocity with which body is displaced.

$\therefore P = F * v = F v \cos \theta$

where θ is the smaller angle between F and v.

power is a scalar quantity. Its S1 unit is watt and its dimensional formula is $[ML^2T^{-3}]$.
Its other units are kilowatt and horse power,

1 kilowatt = 1000 watt

1 horse power = 746 watt

Energy

Energy of a body is its capacity of doing work.

It is a scalar quantity.

Its S1 unit is joule and CGS unit is erg. Its dimensional formula is $[ML^3T^{-3}]$.
There are several types of energies, such as mechanical energy (kinetic energy and potential energy), chemical energy, light energy, heat energy, sound energy, nuclear energy, electric energy etc.

Mechanical Energy
The sum of kinetic and potential energies at any point remains constant throughout the motion. It does not depend upon time. This is known as law of conservation of mechanical energy.

Mechanical energy is of two types:

1. Kinetic Energy

The energy possessed by any object by virtue of its motion is called its kinetic energy.

Kinetic energy of an object is given by

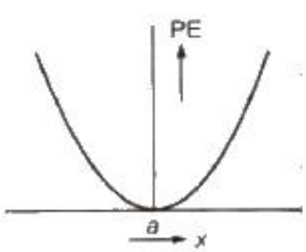
$k = 1 / 2\ mv^2 = p^2 / 2m$
where m = mass of the object, U = velocity of the object and p = mv = momentum of the object.

- 2. Potential Energy

The energy possessed by any object by virtue of its position or configuration is called its potential energy.

There are three important types of potential energies:

(i) Gravitational Potential Energy If a body of mass m is raised through a height h against gravity, then its gravitational potential energy = mgh,



(ii) Elastic Potential Energy If a spring of spring constant k is stretched through a distance x. then elastic potential energy of the spring = 1 . 2 kx^2

The variation of potential energy with distance is shown in figure.

Potential energy is defined only for conservative forces. It does not exist for non-conservative forces.

Potential energy depends upon frame of reference.

(iii) Electric Potential Energy The electric potential energy of two point charges ql and q'l. separated by a distance r in vacuum is given by

$U = 1 / 4\pi\Sigma_0 * q_1q_2 / r$

Here $1 / 4\pi\Sigma_0 = 9.0 * 10^{10}$ N-m^2 / C^2constant.

Work-Energy Theorem

Work done by a force in displacing a body is equal to change in its kinetic energy.

$$W = \int_{v_1}^{v_2} F \cdot ds = \frac{1}{2} mv_2^2 - \frac{1}{2} mv_1^2 = K_f - K_i = \Delta\text{KE}$$

where, K_i = initial kinetic energy

and K_f = final kinetic energy.

Regarding the work-energy theorem it is worth noting that

(i) If W_{net} is positive, then $K_f - K_i$ = positive, i.e., $K_f > K_i$ or kinetic energy will increase and vice-versa.

(ii) This theorem can be applied to non-inertial frames also. In a non-inertial frame it can be written as:

Work done by all the forces (including the Pseudo force) = change in kinetic energy in non-inertial frame.

Mass-Energy Equivalence

According to Einstein, the mass can be transformed into energy and vice – versa.

When Δm. mass disappears, then produced energy

$E = \Delta mc^2$

where c is the speed of light in vacuum.

Principle of Conservation of Energy

The sum of all kinds of energies in an isolated system remains constant at all times.

Principle of Conservation of Mechanical Energy

For conservative forces the sum of kinetic and potential energies of any object remains constant throughout the motion.

According to the quantum physics, mass and energy are not conserved separately but are conserved as a single entity called 'mass-energy'.

Collisions

Collision between two or more particles is the interaction for a short interval of time in which they apply relatively strong forces on each other.

In a collision physical contact of two bodies is not necessary. rrhere are two types of collisions:

1. Elastic collision

The collision in which both the momentum and the kinetic energy of the system remains conserved are called elastic collisions.

In an elastic collision all the involved forces are conservative forces.

Total energy remains conserved.

2. Inelastic collision

The collision in which only the momentum remains conserved but kinetic energy does not remain conserved are called inelastic collisions.

In an inelastic collision some or all the involved forces are non-conservative forces.

Total energy of the system remains conserved.

If after the collision two bodies stick to each other, then the collision is said to be perfectly inelastic.

Coefficient of Restitution or Resilience

The ratio of relative velocity of separation after collision to the velocity of approach before collision is called coefficient of restitution resilience.

It is represented by e and it depends upon the material of the collidingI bodies.

For a perfectly elastic collision, $e = 1$

For a perfectly inelastic collision, $e = 0$

For all other collisions, $0 < e < 1$