WORK AND ENERGY

RELATION BETWEEN MOMENTUM AND KE

Kinetic energy

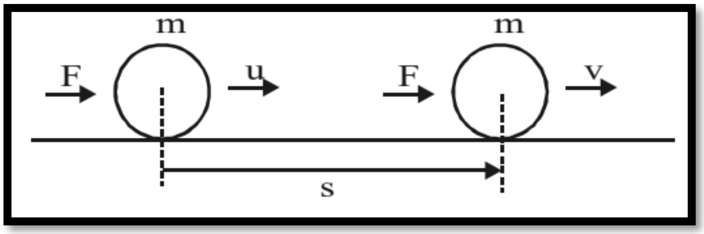
A moving object is capable of doing work because of it" motion. Hence, we say that the object has kinetic energy. "Kinetikos" in Greek means "to move". Hence, kinetic energy means energy due to motion. The energy is stored in the object when work is done to change its velocity from a lower value to a higher value, or from rest to certain velocity. Kinetic energy of an object is defined as the energy which it possesses by virtue of its motion, and is measured by the amount of work that the object can do against an opposing force before it comes to rest. Kinetic energy of an object moving with a certain velocity is equal to the work done on it to enable it to acquire that velocity.

Examples of bodies possessing kinetic energy

1. A ball rolling on a surface because it can set another ball into motion by striking it.
2. A bullet fired from a gun as it is able to penetrate some distance into a target which it strikes.
3. A torpedo in motion as it can do work by penetrating into the side' of a ship.
4. Water in motion as it can turn a wheel or a turbine.
5. A fast wind as it can set a boat in motion when striking against its sail.
6. A moving hammer as it drives a nail into a wall against the resistance offered to it by the wall.
7. A falling body as it can break something on which it falls.

Expression for kinetic energy

Consider an object of mass m which is moving with an initial velocity u on a perfectly frictionless surface. Let a constant external force F act on it and produce an acceleration a in it. If v is the final velocity of the object after having undergone a displacement s, then from



$$v^2 - u^2 = 2as, s = \frac{v^2 - u^2}{2a} \quad \dots (1)$$

Work done by the force in displacing the body through s, i.e.,

$$W = F \times s \quad \dots (2)$$

We know from Newton's Second Law of Motion,

$$F = ma \quad \dots (3)$$

From equation (1), (2) and (3), we get

$$W = (ma) \times \frac{(v^2 - u^2)}{2a} = \frac{m(v^2 - u^2)}{2}$$

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \quad \dots (4)$$

If the object is initially at rest, u = 0 and as such from eqn. (4),

$$W = \frac{1}{2}mv^2 \quad \dots (5)$$

This work done (W) in making the object acquire a velocity v after starting from rest has not gone waste and is, in fact, stored in the object.

Work stored up in a moving object is called the kinetic energy of the object. If kinetic energy of an object is denoted by E_k then

$$E_k = \frac{1}{2}mv^2 \quad \dots (6)$$

Kinetic energy of a moving object is defined as half the product of the mass of the object and the square of the speed of the object.

Factors affecting Kinetic energy:

(i) The more the mass of a body, the greater its kinetic energy.

(ii) The more the velocity of a body, the more its kinetic energy.

(iii) Kinetic energy of a body depends both on its mass and velocity.

Relation Between Momentum and Kinetic Energy

Kinetic energy and momentum of a moving body can be mathematically related as follows-

Consider the formula of kinetic energy-

$$K.E = \frac{1}{2}mv^2$$

Multiply and divide R.H.S by m,

$$\Rightarrow K.E = \frac{1}{2}mv^2 \times \frac{m}{m}$$

$$= \frac{m^2v^2}{2m}$$

$$= \frac{(mv)^2}{2m}$$

We know that

$$P = ve$$

. Substituting for mv in the above equation we get-

$$K.E = \frac{p^2}{2m}$$

The above equation gives the relation between kinetic energy and momentum of the object which is under motion.

If the Momentum(p) is constant $K.E \ \alpha \ \frac{1}{m}$

If Kinetic Energy(K.E) is constant $p \ \alpha \ \sqrt{m}$

If mass(m) is constant $p \ \alpha \ \sqrt{K.E}$