# WORK, POWER AND ENERGY

## KINETIC ENERGY

### Kinetic Energy

To accelerate an object, we have to apply force. To apply force, we need to do work. When work is done on an object, energy is transferred, and the object moves with a new constant speed. We call the energy that is transferred kinetic energy, and it depends on the mass and speed achieved.

### The kinetic energy definition in Physics is given as:

Kinetic energy of an object is the measure of the work an object can do by virtue of its motion.

Kinetic energy is a scalar quantity, and it is entirely described by magnitude alone.

### Units of Kinetic Energy

The SI unit of kinetic energy is Joule which is equal to 1 kg.m2.s-2.

The CGS unit of kinetic energy is erg.

### Kinetic Energy Examples

- A truck travelling down the road has more kinetic energy than a car travelling at the same speed because the truck's mass is much more than the car's.
- A river flowing at a certain speed comprises kinetic energy as water has a certain velocity and mass.
- The kinetic energy of an asteroid falling towards earth is very large.
- The kinetic energy of the aeroplane is more during the flight due to its large mass and speedy velocity.

## Kinetic Energy Transformation

Kinetic energy is transferred between objects and can be transformed into other forms of energy. Yo-Yo is a great example to describe the transformation of kinetic energy. While beginning to play with it, one starts by letting it rest in hand; at this point, all the energy is stored in the ball in the form of potential energy. Once the person drops the yo-yo, the stored energy is transformed into kinetic energy, the energy of movement. Once the ball reaches the bottom of the yo-yo, all the energy is converted to kinetic energy.

## The Formula for Kinetic Energy

$$KE = \frac{1}{2}mv^2$$

The kinetic energy equation is given as:

## Deriving Kinetic Energy Equation

Kinetic energy equation can be obtained by the basic process of computing the work (W) that is done by a force (F). If the body of mass m was pushed for a distance of d on a surface by applying a force that's parallel to it, then the work done would be:

$$W = F.d = m.a.d$$

The acceleration in this equation can be substituted by the initial (vi) and final (vf) velocity and the distance. This we get from the kinematic equations of motion.

$$W = m \cdot a \cdot d$$

$$m \cdot d \cdot \frac{v_f^2 - v_i^2}{2d}$$

$$m \cdot \frac{v_f^2 - v_i^2}{2d}$$

$$\frac{1}{2} \cdot m \cdot v_f^2 - \frac{1}{2} \cdot m \cdot v_i^2$$

Simplifying the equation further, we get

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

Alternately, one can say that the total work that is done on a system is equivalent to the change in kinetic energy. This statement is equated as follows:

$$W_{net} = \Delta K$$

This equation is known as the work-energy theorem and has large applications even if the forces applied vary in magnitude and direction.

## Is Kinetic Energy a Vector or a Scalar Quantity

In the expression, we see that velocity (v) is squared. We know that the square of a vector quantity is a scalar, and we also know that mass is a scalar quantity. Therefore, kinetic energy is a scalar quantity.

## Kinetic Energy Calculation

**Ex.** Calculate the kinetic energy of a 200 kg object that is moving at a speed of 15 m/s.

**Sol:** The kinetic energy of the body can be calculated using the following equation:

$$KE = \frac{1}{2}mv^2$$

Substituting the values in the above equation, we get

$$KE = \frac{1}{2}(200kg)(15m/s)^2$$

$$KE = 45000J \text{ or } 45KJ$$

## Types of Kinetic Energy

There are five types of kinetic energy: radiant, thermal, sound, electrical and mechanical. Let us look at some of the kinetic energy examples and learn more about the different types of kinetic energy.

### Radiant energy

Radiant energy is a type of kinetic energy that is always in motion travelling through medium or space. Examples of radiant energy are:

- Ultraviolet light
- Gamma rays

### Thermal energy

Thermal energy, known as heat energy, is generated due to the motion of atoms when they collide with each other. Examples of thermal energy are:

- Hot springs
- Heated swimming pools

### Sound energy

The vibration of an object produces sound energy. Sound energy travels through the medium but cannot travel in a vacuum as there are no particles to act as a medium. Examples of sound energy are:

- Tuning fork
- Beating drums

### Electrical energy

Electrical energy is obtained from the free electrons that are of positive and negative charge. Examples of electrical energy are:

- Lightning
- Batteries when in use

## Mechanical energy

The sum of kinetic energy and potential energy is known as mechanical energy, which can neither be created nor be destroyed but converted from one form to another. Examples of mechanical energy are:

- Orbiting of satellites around the earth
- A moving car