Work, Power and Energy

The Concept of Potential Energy

Introduction to Potential Energy

In the 19th Century, a Scottish engineer and physicist, William Rankine, introduced the term potential energy. There are different kinds of potential energy. Each of them is related to a different kind of force. It is the energy by virtue of an object's position relative to other objects.

You must know that an object has the ability to store energy because of its position. For instance, take a look at a bow and arrow. When you draw the boy, it stores a certain amount of energy. It is responsible for kinetic energy it gains when you release it.

Definition of Potential Energy

Potential energy refers to the energy which an object holds due to its position relative to other objects, stresses within itself, its electric charge, or other factors. Likewise, if you take the example of spring, it gains a certain amount of energy when we displace it from its <u>equilibrium</u> position.

You can observe this energy in the form of stress you feel in your hand when you stretch it. Moreover, you can define potential energy as a kind of energy which results when the position or state alters.

The Formula of Potential Energy

The formula for potential energy is dependent on the force which acts on the two objects. For the gravitational force the formula is:

 $W = m \times g \times h = mgh$

Over here, m refers to the mass in kilograms whereas g is the acceleration because of gravity. Moreover, h refers to the height in meters.

Unit

Gravitational potential energy has the same units as kinetic energy. It is kg m² / s^2 . Most noteworthy, all energy has the same units as the above and measured using the unit Joule (J).

Types of Potential Energy

As you know by now, potential energy is one of the two major forms of energy. The other one is kinetic energy. There are two kinds of potential energy, which are:

- Gravitational Potential Energy
- Elastic Potential Energy

Gravitational Potential Energy

We define this energy as the energy which an object possesses when it has risen to a particular height against <u>gravity</u>. In order to help you understand it better, consider an object of mass as m. It is positioned at a height h from the ground.

Thus, you will see that the force we require to raise the object equals the $m \times g$ of the object. Moreover, as the object is raised against the force of gravity, some amount of work (W) is done on it

Therefore, work done on the object = force \times displacement.

So, the potential energy formula will be: $W = m \times g \times h = mgh$

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According to the law of conservation of energy, as the work is done on the object is equal to $m \times g \times h$, the energy which the object gains = $m \times g \times h$. Thus, in this case, it is the potential energy E.

So, the E of an object raised to a height h above the ground will be $m \times g \times h$.

Most noteworthy, gravitational energy is not dependent on the distance which the object travels, but on the displacement, which is the difference between the initial and the final height of the object.

Therefore, we will not consider the path along which the object has reached the height. So, looking at examples, you will notice that the gravitational potential energy for both the blocks A and B is going to be the same.

Elastic Potential Energy

Elastic potential energy refers to the energy which is stored in objects which we can compress or stretch like rubber bands, trampoline and bungee cords. Thus, the more you stretch an object, the more elastic potential energy it will possess.

Moreover, many of the objects are particularly designed in a way so that they can store this energy. For instance, a stretched bow of an archer, a wind-up clock's coil spring, a twisted rubber band which powers a toy plan and the board of a bent diver before he dives in.

Further, you will notice that an object which can store elastic potential energy usually has a high elastic limit. But, all elastic objects have a threshold to the load which they can sustain.

In other words, if we deform it beyond the elastic limit, the object will not be able to return to its original shape. We can calculate elastic potential energy by using the formula of U=12kx2.

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Over here, U is the elastic potential energy, k refers to the spring <u>force</u> constant. Finally, x refers to the string stretch length in m.

Examples of Potential Energy

You will notice that all tree branches high up the tree possess potential energy as they can fall at any time to the ground. Moreover, the food which we consume every day also comprises of this energy as it offers us the necessary energy for bodily functions.

The stones which you see sitting on an edge of a cliff possesses potential energy. If the stones fall, the potential energy will convert into kinetic energy. Further, a firecracker also possesses this energy as its chemical release when we light up its fuse.