Classical Mechanics

First stage

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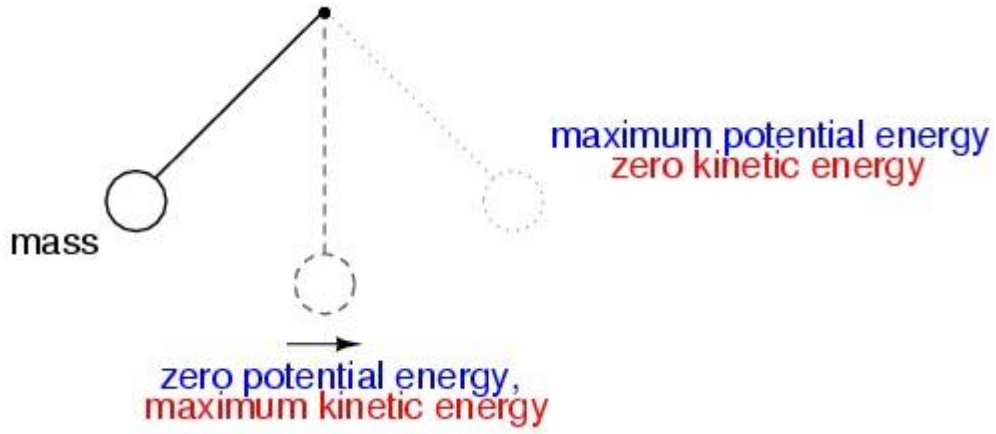
Lecture 10

What is Mechanical Energy?

Mechanical energy is the sum of kinetic energy and potential energy in an object that is used to do a particular work. In other words, it describes the energy of an object because of its motion or position, or both

Let us consider the example of an ideal simple pendulum (friction-less). We can see that the mechanical energy of this system is a combination of its kinetic energy and gravitational potential energy. As the pendulum swings back and forth, a constant exchange between the kinetic energy and potential energy takes place. When the bob attains its maximum height, the potential energy of the system is the highest, whereas the kinetic energy is zero. At the mean position, the kinetic energy is the highest, and the potential energy is zero. Between these two extreme points, we see that the system possesses both kinetic and potential energy, the sum of which is constant. These observations tell us a lot about the conservation of mechanical energy. But how can we prove it for every other system? In the next section, we shall learn more about the conservation of mechanical energy using a suitable example.



Conservation of Mechanical Energy

According to the principle of conservation of mechanical energy,

The total mechanical energy of a system is conserved i.e., the energy can neither be created nor be destroyed; it can only be internally converted from one form to another if the forces doing work on the system are conservative in nature.

In order to understand this statement more clearly, let us consider an example of one-dimensional motion of a system. Here a body, under the action of a conservative force F, gets displaced by Δx, then from the work-energy theorem, we can say that the network done by all the forces acting on a system is equal to the change in the kinetic energy of the system.

Mathematically, $\Delta KE = F(x)\, \Delta x$

Where, ΔK is the change in kinetic energy of the system. Considering only conservative forces are acting on the system $W_{net} = W_c$.

Thus $W_c = \Delta KE$

Also, If conservative forces do the work in a system, the system loses potential energy equal to the work done. Hence, $W_c = -PE$.

Which implies that the total kinetic energy and potential energy of a system remains constant if the process involves only conservative forces.

KE + PE = constant

$KE_i + PE_i = KE_f + PE_f$

Where denotes the initial values and f denotes the final values of KE and PE.

Difference Between Kinetic and Potential Energy

Sr.no	Kinetic Energy	Potential Energy
1.	Kinetic energy is the kind of energy present in a body due to the property of its motion	Potential Energy is the type of energy present in a body due to the property of its state
2.	It can be easily transferred from one body to another	It is not transferable
3.	The determining factors for kinetic energy are Speed or velocity and mass	Here, the determining factors are Height/ distance and mass
4.	Flowing water is one of the examples of kinetic energy	Water present at the top of a hill is an example of potential energy
5.	It is relative with respect to nature	It is non-relative with respect to nature

State the principle of conservation of mechanical energy.

The total mechanical energy of a system is conserved i.e., the energy can neither be created nor be destroyed; it can only be internally converted from one form to another if the forces doing work on the system are conservative in nature.

Define mechanical energy of the system

The mechanical energy of the system is defined as the total kinetic energy plus the total potential energy.

Is kinetic energy conserved in elastic collisions?

Yes, kinetic energy is conserved in elastic collisions.

Name the device which converts electrical energy into mechanical energy Electric motor.

Give an example where heat energy is converted into mechanical energy?

Heat engine.

What is the formula of conservation of mechanical energy?

Ans: The formula representing the conservation of mechanical energy is $Em=Ep+Ek=mgh+12mv^2=Constant$

What is a non-conservative force?

Ans: If the work done by a force depends on the path taken between the initial and the final position, it is called a non-conservative fore. Frictional force is a nonconservative force.

Example 1: An object of mass 200g *is raised to a height* 5m5m *above the ground. Calculate it potential energy at*

this height. If the object is made to fall, what will be its kinetic energy halfway down?

Take g=10ms2g=10ms2.

Solution: Given that, The

mass of the object is

m=200g =0.2kgm=

The height of the object is h=5m

The acceleration due to gravity is $g=10ms^2$ The potential energy of the object at the height is

P.E=mgh=0.2×10×5=10J