

Class Nine Academic Program-2020

PHYSICS

Lecture : P-09

Chapter 4 : Work, Energy & Power





- **Definition:**

The product of applied force on an object and the displacement or the component of displacement towards the force during the application of force is known as Work.



Work = Scalar;

$$W = \vec{F} \cdot \vec{S} \rightarrow \text{Dot Product} = F \cos \theta$$

Unit: J/Nm

Dimension:

$$\rightarrow J \rightarrow Nm$$

$$\rightarrow Kgms^{-2}m$$

$$\rightarrow Kgm^2s^{-2}$$

So,

$$[W] = [M L^2 T^{-2}]$$

Problem



- 10N force is applied on an object for 5s and therefore displacement occurs 5m towards force. But, due to inertia of motion, the object moves 3m more. Work done =?

Classification of Work

- **1. Positive Work:**

→ Lift up a Pen. Your work.....

- **2. Negative Work:**

→ Lift up a Pen. Earth's Work.....

Energy

(Ability to do work is called Energy.)

During Positive Work → Giving Energy to the Object

During Negative Work → Taking away Energy from the Object....

Energy

Work Done = Energy Created/ Released.

Unit: J/Nm

Dimension:

$$\rightarrow J \rightarrow Nm$$

$$\rightarrow Kgs^{-2}m$$

$$\rightarrow kgm^2s^{-2}$$

So,

$$[E] = [ML^2T^{-2}]$$

Different Forms of Energy

- **Mechanical Energy :**

(The energy that obtained due to Position, Shape & Motion of object is known as Mechanical Energy.)

Two Types:

→ Kinetic Energy

→ Potential Energy

Kinetic Energy

****The Energy due to Motion is called Kinetic Energy.**

We Know,

Energy released / created = Work Done

So,

$$E_k = W = Fs$$

$$E_k = mas \dots (i)$$

But,

$$v^2 = u^2 + 2as$$

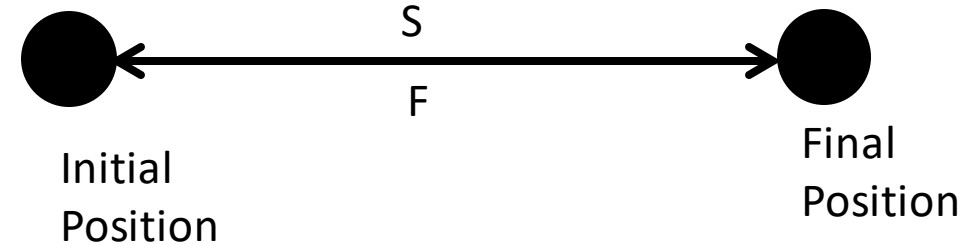
$$\Rightarrow v^2 = 2as \quad [\because u = 0]$$

$$\Rightarrow as = \frac{v^2}{2}$$

$$\therefore (i) \Rightarrow$$

$$E_k = m \times \frac{v^2}{2} = \frac{1}{2}mv^2$$

$$E_k = P^2 / 2m ?$$



- **If the momentum of an object becomes 2 times, then the kinetic energy will be:**
 - A) 4 times
 - B) 2 times
 - C) 1.41 times
 - D) 8 times

Work-Energy Theorem

We Know,

$$v^2 = u^2 + 2as$$

Multiplying both sides by $\frac{1}{2}m \Rightarrow$

$$\Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}mu^2 + \frac{1}{2}m \times 2as$$

$$\Rightarrow \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = mas = Fs$$

$$\Rightarrow \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = W$$

Work –Energy Theorem.

Problem

- A force of 10N is applied on a stationary object of mass 10kg for 10s.
- a) Calculate the kinetic energy after 10s.
- b) Calculate the kinetic energy after 20s.
- c) Calculate the kinetic energy if Force is applied for total 20s.

Solution

Potential Energy

****The energy that happens due to change of position & shape of an object,.....**

Suppose, an object mass of 'm' is placed on a building of 'h' height. Then, due to change of position, the potential energy, $E_p = mgh$

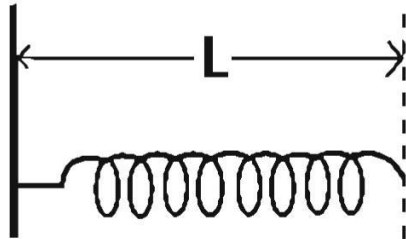
Quiz

Can Kinetic Energy be negative?

- Potential energy can be:
 - A) Positive
 - B) Negative
 - C) 0
 - D) All

Spring

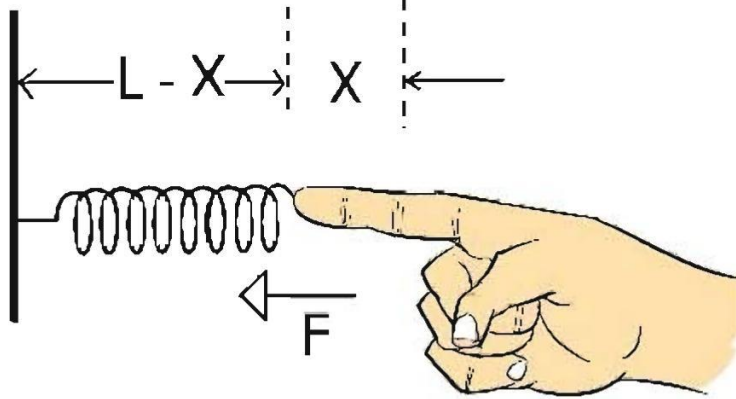
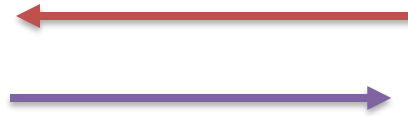
- For a spring, Potential Energy, $E_p = \frac{1}{2} Kx^2$; $K = \text{Spring Constant}$, $x = \text{Expansion / Compression}$.



Here,

$F_{\text{man}} = \text{Human}$

$F_{\text{spring}} = \text{Spring}$



Law of Conservation of Energy

Q. A body of mass 10kg fell on a spring with a velocity of 10 m/s. If Spring Constant =100000 J/m² or N/m, what was the compression of the spring?

Problem

Q. At which height does Kinetic Energy become 2 times of Potential Energy if the object falling from 30m height?

Solution

Shortcut♥♥



Here, **n** means how many
times will be Kinetic
Energy of Potential Energy

$$\text{Shortcut} \Rightarrow x = \frac{h}{n+1}$$

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প্রতিভাকে ধ্বংস করে।