WORK, ENERGY AND POWER - PART I

toppr

Forms Of Energy

Heat Energy

Heat is defined as the flow of energy from a warmer to a cooler body.

Chemical Energy

Energy that binds atoms and molecules together.

Nuclear Energy

Energy that binds protons and neutrons together in the nucleus.

Electrical Energy

Energy stored in the charged particle.

Mechanical Energy

Sum total of an object's kinetic and potential energy at any given time.

Kinetic Energy(K.E.)

The ability of an object to do work because its motion. It is measured in Joules(J).

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

Potential Energy(P.E.)

The capacity of an object to do work by virtue of its position. It is measured in Joules(J).

$$P.E. = mgh$$

Elastic Potential Energy(U)

Objects behaving like an elastic or spring possesses this energy.

Spring Force, F = kx

where, k = spring constant

x = amount of compression or stretch.

Elastic Potential Energy, $U = \frac{1}{2} kx^2$

Gravitational Potential Energy(U_g)

Energy stored in an object as a result of its height.

$$U_g = mgh$$

Chemical Potential Energy

Energy stored in the chemical bond of a substance.

Work

- Work is said to be done when an acting force displaces a particle.
- No displacement = No work.
- Work done, $W = \vec{F}.\vec{d}$
- Work is a scalar quantity.

Work Energy Theorm

$W = \Delta k$

$W = (½)mv^2 - (½)mu^2$

Where,

W = Work done = FS

F = Applied force

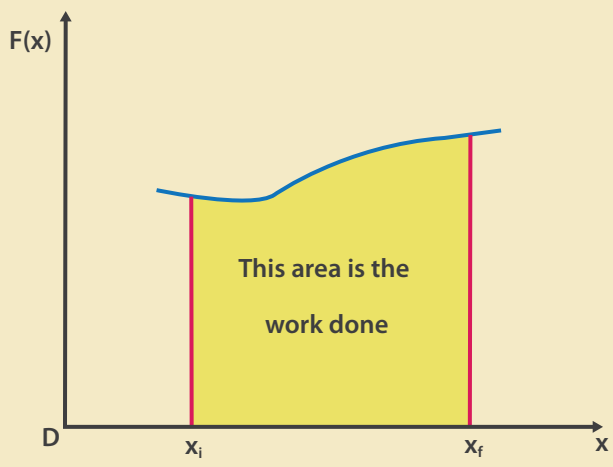
S = displacement

m = mass of the object

u = Initial velocity

v = Final velocity

Work Done Under Varaible Force



$$W = \int_{x_i}^{x_f} F(x)dx$$

Law Of Conservation Of Energy

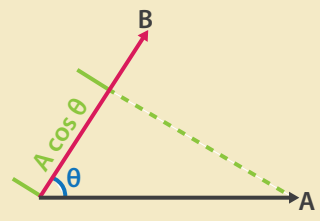
Energy can be neither be created nor be destroyed. Energy only changes its form.

Law Of Conservation Of Mechanical Energy

$$(K.E.)_i + (P.E.)_i = (K.E.)_f$$

Scalar Product

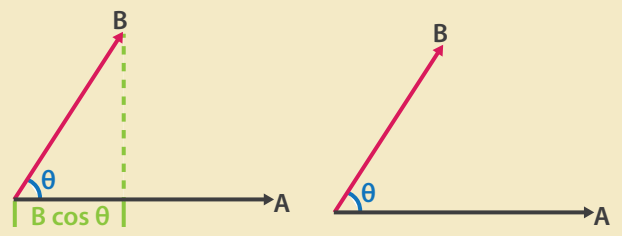
- Projection of one vector on another



- $A.B = |A|\,|B| \cos\theta$

Where,

θ = smaller angle between vector A and B



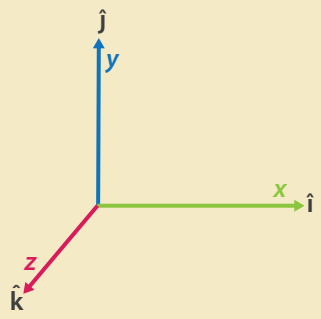
- A.B = B.A
- A.(B + C) = A.B + A.C
- $\hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$
- $\hat{i}.\hat{j} = \hat{j}.\hat{k} = \hat{i}.\hat{k} = 0$
- If,

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

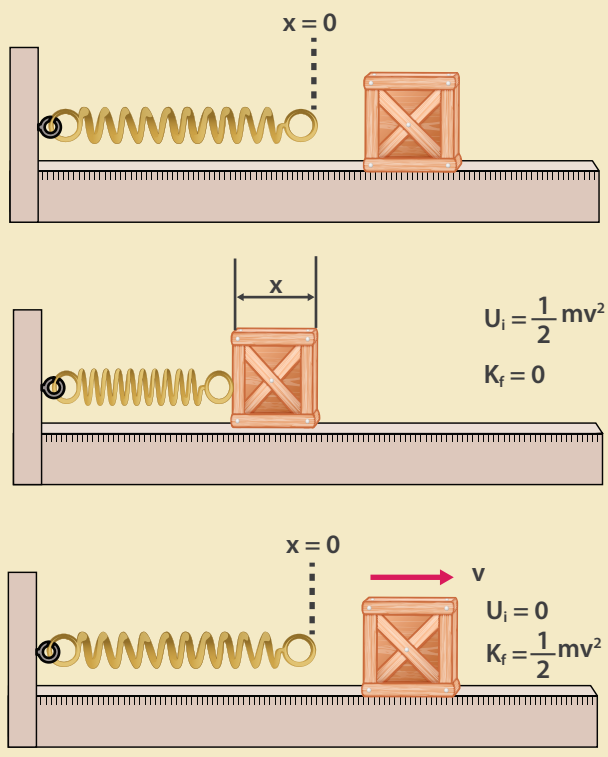
Then,

$$\vec{A}.\vec{B} = A_xB_x + A_yB_y + A_zB_z$$



Spring Potential Energy

Work done by the spring



$$W = \int_0^{x_m} F dx = -\frac{1}{2} k(x_m)^2$$

Work done in displacing the object from initial displacement x_i to final displacement x_f.

$$W = \int_{x_f}^{x_i} kx\,dx = \frac{1}{2} k(x_i)^2 - \frac{1}{2} k(x_f)^2$$

Power

- Rate at which work is done.
- Power is scalar quantity.
- SI Unit = Watt(W), Horsepower(hp)

$$P = \frac{W}{t}$$

$$P = \vec{F}.\vec{v}\ \ Fv\cos\theta$$

- 1 hp = 746 W

Kilo-Watt-hour(KWh)

- KWh is the unit of energy.
- Most commonly used in electricity bills to denote electrical units consumed.
- 1 KWh is consumption of 1000 W power for 1 hour.
- 1 KWh = 1000 W X 3600 s = 3600000 J