Work and Energy - Notes

Notes Important Questions

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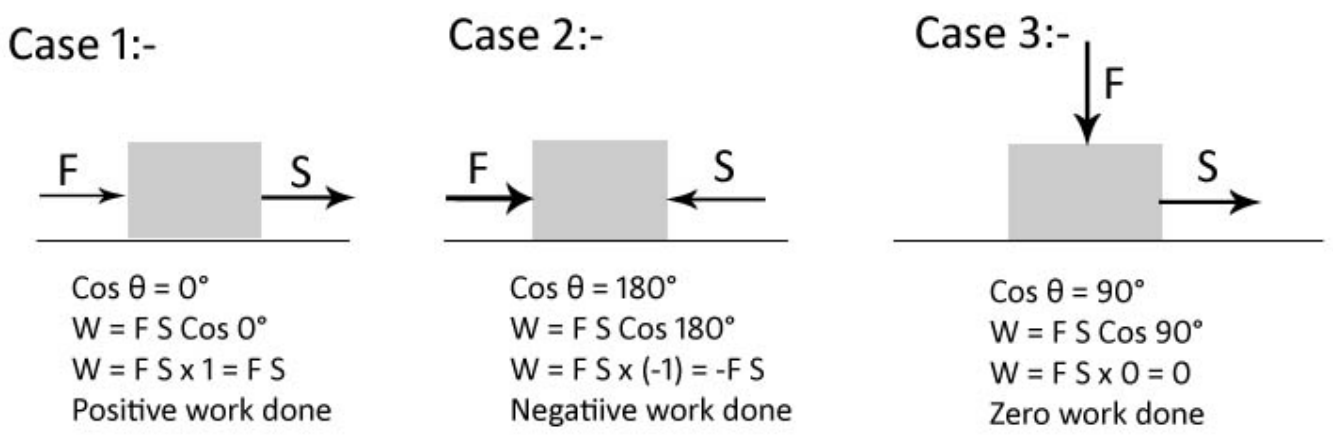
Work:- Work is said to be done if a force is applied on an object & it displaces in the direction of force applied.

- S.I. unit:- **Joule (J)**
- It is a **scalar** quantity.
- Work done = Force x displacement (**W = FS**)

1 Joule :- The work done on an object is said to be 1 joule when a force of 1 N displaces it by 1 m along the line of action of the force.

Positive, Negative and Zero Work Done:-

- **W = F S Cos ?**



Energy:- The capacity of doing work is called energy.

- S.I. unit :- **Joule (J)**

Kinetic energy:- The energy possessed by an object by virtue of its motion is known as kinetic energy. **Ex:-** Moving fan.

Expression of kinetic energy:-

Consider an object having mass 'm' moving with uniform acceleration 'a'. Let its initial velocity be 'u' & final velocity be 'v'.

From **2nd** law of motion, F = ma

W = FS

or, W = ma(v^2-u^2)/2a **[**Since, **v^2-u^2 = 2aS** So, **S = (v^2-u^2)/2a]**

or, W = m(v^2-u^2)/2 = ½ m(v^2-u^2)

If u = 0 then, W = ½ m(v^2-0^2) = ½ mv^2

So, $\mathbf{E_k = ½\ mv^2}$

Work done= Change in kinetic energy

or, $W = E_{kf} - E_{ki}$

or, $\mathbf{W = ½\ mv^2 - ½\ mu^2}$

Potential energy:- The energy possessed by an object by virtue of its position or configuration is known as its potential energy. **Ex:-** Water stored in a dam.

Expression of potential energy:-

Consider an object having mass 'm' at a height 'h'.

From $\mathbf{2^{nd}}$ law of motion,

F = ma = mg (Where, g is acceleration due to gravity.)

Now, W = FS

or, W = mgh [here, **S = h**]

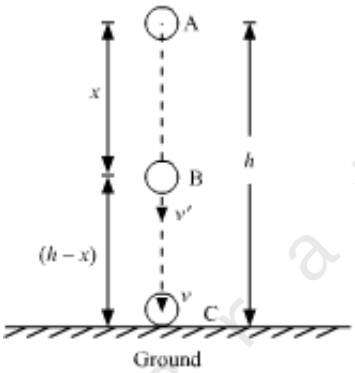
So, $\mathbf{E_p = mgh}$

Law of conservation of energy:-It states that energy can neither be created nor be destroyed. It can only be converted from one form to another.

Mechanical energy:- The sum of kinetic energy & potential energy of an object is known as mechanical energy.

- **Mechanical energy = Potential energy +Kinetic energy = constant**

Mathematical proof of conservation of mechanical energy for a freely falling object:-



Consider an object having mass 'm' at height 'h'.

At point A, velocity = 0, acceleration = g and height = h

K.E. = ½ mv^2 = ½ $m.0^2$ = 0

P.E. = mgh

M.E. = K.E.+P.E. = 0 + mgh = mgh

At point B,

Using, $v^2-u^2 = 2aS$

or, $v^2 = 0^2+2gx$ [here,u=0, a=g & S=x]

or, $v^2 = 2gx$

K.E.= ½ mv^2 = ½ m.2gx = mgx

P.E.= mg(h-x) = mgh - mgx

So, M.E.=K.E.+P.E. = mgx + mgh - mgx = mgh

At point C,

Using, $v^2-u^2 = 2aS$

or, $v^2= u^2+2aS = 0^2+2gh = 2gh$

K.E.= ½ mv^2 = ½ m(2gh) = mgh

and P.E.= mgh = mg.0 = 0

so, M.E.= K.E.+P.E. = mgh+0 = mgh

Clearly, the total mechanical energy for a freely falling object is 'mgh' i.e., constant at every point.

Power:- The rate of doing work is called power.

- Power= work/time **(P=W/t)**
- S.I. unit :- **J/S** or **Watt (W)**

1 watt of power:- The power of an agent is said to be 1 watt if it does 1 J work in 1 sec.

- 1 kW = 1000 W = 1000 J/s
- Commercial unit of energy :- kilowatt hour (**kW h**)

Conversion of commercial unit of energy to S.I. unit of energy:-

1 kwh = 1000 W x 3600 sec = 3.6 $x10^6$ W sec = 3.6 $x10^6$ J

or, **1 unit = 1 kwh = 3.6 x 10^6 J**