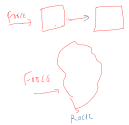
Work and Energy



- Work is done when produces motion.

$W = F \times S$

↑ Force ↑ displacement

- Work done by a force on a body depends upon two factors
  - → Magnitude of force.
  - → Displacement through which the body moves.

$W = F \times S$

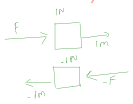
→ Work done in moving a body is equal to the product of force exerted on the body and the distance moved by the body in the direction of force.

→ $W = F \times S$
$= N \times m$
$W = \text{Joule}$

$1 \text{ Joule} = 1N \times 1M$

Note 1 J is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.

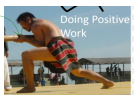
→ Work is a scalar quantity.



$W = F \times S$
$= 1N \times 1m$
$= 1Nm = 1J$

$W = F \times S$
$= -1N \times -1m$
$= 1Nm = 1J$

Positive and Negative work



When displacement of an object is in the same direction as that of force applied it is called Positive work done

→ Work done by man → +ve

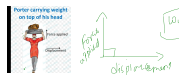
→ Work done by gravitational force → -ve

Negative work - when displacement of an object is in the opposite direction of applied force then it is negative work done.

Zero work done

$W = F \times S$
$= 0$

$\boxed{W = 0}$



Work done = 0

Example 11.1 A force of 5 N is acting on an object. The object is displaced through 2 m in the direction of the force (Fig.

2) Calculate the work done in lifting 200kg of water through a vertical height of 6 meters. (Assume $g = 10 ms^{-2}$)

$W = F \times S$
$W = m \times a \times S$
$= m \times g \times h$
$= 200 \times 10 \times 6$
$W = 12000 J$

3) A car weighing 1000kg & travelling at $30 ms^{-1}$ stops at a distance of 50m decelerating uniformly. What is the force exerted on it by the brakes? What is the work done by the breaks

$W = F \times S$
$= 900 \times 50$
$= 45 KJ$

$F = ma$

$F = -900N$

$v^2 - u^2 = 2as$
$0 - 900 = 2 \times a \times 50$
$a = -9 ms^{-2}$

Energy

→ The ability to do work.

A ——→ Fast↑ Energy↑ work done↑

A' ——→ B' Fast↓ Energy↓ work done↓

The amount of energy possessed by a body is equal to the amount of work it can do when its energy is released.

$\boxed{WD = KE_i - KE_f}$

- Energy is a scalar qty.

Unit of Energy

→ Units of work and energy are the same i.e. joule.

$1 Kj = 1000 \text{ Joules}$

Different forms of Energy

Kinetic energy, chemical energy, Potential energy.

Kinetic Energy

$(WD)_1 > (WD)_2$

WD → velocity
K.E → velocity

WD → mass
K.E → mass.

$\boxed{W = F \uparrow dm}$

Work $= F \times S$

Now finding S

$v^2 - u^2 = 2as$
$S = (v^2 - u^2)/2a$

Putting value of S in above equations

$W = F \times S$
$W = ma \times (v^2 - u^2)/2a$
$W = m(v^2 - u^2)$

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

The K.E Possessed by an object of mass m and moving with a uniform velocity v

$\boxed{\text{work done} = \Delta KE}$

2) If the mass of a body is doubled/halved its KE. also gets doubled / halves

→ If the velocity of a body is doubled/halved its KE becomes four times / one-fourth respectively.

1) An object of mass 15 kg is moving with a uniform velocity of $4 ms^{-1}$. What is the KE possessed by the object?

2) What is the work to be done to increase the velocity of a car from $30 km h^{-1}$ to $60 km h^{-1}$ if the mass of the car is 1500 kg?

$30 \times \frac{5}{18}$ $60 \times \frac{5}{18}$

$WD = KE_i - KE_f$
$= \frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2$
$= 156250 J$

3) How much work done on a bicycle of mass 20kg to increase its speed from $2ms^{-1}$ to $5ms^{-1}$. (Ignore friction & air resistance)

→ 210 J

4) Two bodies of equal masses move with uniform velocities v and 3v respectively. Find the ratio of K.E's.