The word ‘work’ has many different meanings. In physics, however, it has a special meaning. **When a force acts on an object moves, we say that the force has one work on the object.**

When an apple falls from a tree, the force of attraction of the earth does work on the apple. Work is always done by a force. **The work done by a force acting on an object to equal to the product of the force and the displacement of the object in the direction of the force.** We assume here that the force remains constant during the whole displacement. Note that both force and displacement have directions, i.e., they are vectors. Work, which is a product of force and displacement, does not have a direction. It is a scalar quantity.

Unit of Work: Work done is the product of force and displacement. Using the SI units of force and displacement, i.e., newton and metre respectively, the unit of work comes out to be ‘newton metre’. This is given a separate name, **joule**, in honour of the British scientist James Prescott Joule. The symbol of joule is J. When a force of 1 N acts on an object and the object moves a distance of 1 m in the direction of the force, the work done by the force is 1 J.

Displacement in the direction of the force: If the displacement of an object is in the direction of the force applied on it, the amount of the work done by the force on this object is obtained by multiplying the force and the displacement.

When Displacement is Along the force	Work done = force × displacement = F x s

Displacement in the direction opposite to the force: In certain cases, the displacement of an object may be in the direction opposite to the direction of the force acting on it. If the force acting on an object and its displacement are in opposite directions, the work done by the force on the object is

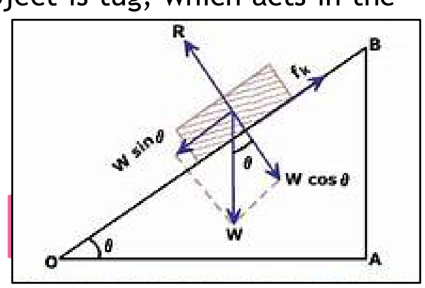
$W = - F \times s$, where F is the force and s is the displacement of the object.

When Displacement is opposite the force	Work done = - (Force × displacement)

Displacement in the direction perpendicular to the force: If the displacement of an object is perpendicular to the force acting on it, the work done by the force on the object is zero. Consider, for example, the force of gravity acting on an aeroplane flying in the sky. The force of gravity is in the downward direction, whereas the aeroplane’s displacement is in the horizontal direction, i.e., the force and the displacement are perpendicular to each other. A coolie carrying load on his head. In this case, force is acting vertically downward (weight of load) and displacement is along horizontal direction i.e. force and displacement are perpendicular to each other. W = 0.

When Displacement is Perpendicular to the force	Work done = zero

Displacement at an angle to the force: Consider an object of mass (m) in sliding on an inclined surface. The force of gravity on this object is tug, which acts in the vertically downward direction. We can say that the object is displaced in the vertically downward direction. Since the displacement in the direction of



ABHYAS Academy, Behind Pragat Shiv Mandir, Near Govt. College, Nishat Cinema Road, Ambala Cantt.
Ph No. +91-171-2631595, 9416541198, e-Mail: anusethi1968@yahoo.com Website: www. abhyasonline.in

the force is AB, the work done is: W = mg (AB)= mg (OB cos θ).
In general, if the displacement "s" of an object makes an angle θ with the force F acting on it, the work done by the force is: **W = Fs cos θ**

General Equation for work Done	Work = force × component of the displacement along the force OR Work = displacement × component of the force along the displacement			
Cos 0°=1	Cos 30°=√3\2	Cos 45°=1\√2	Cos 60°= 1\2	Cos 90°=0

ENERGY: The word 'energy' is used in many contexts, just like the word 'work' is. We hear people talk of a person's energy, energy-giving tonics and drinks, solar energy, nuclear energy, energy from petrol, and so on. Energy is the ability to do work. The object which does the work, losses energy and the object on which work is done, gains energy.
The SI unit of energy is same as that of work i.e. Joule (J). 1 Joule of energy is required to do 1 J of work. Larger unit of energy is kJ. 1kJ = 10^3J.
Work done against a force is therefore stored as energy:
• When a fast moving cricket ball hit a stationary wicket, the wicket is thrown away.
• When a raised hammer falls on a nail placed on a piece of wood, it drives the nail into the wood.
Forms of energy: it exists in various forms like mechanical energy (sum of potential energy and kinetic energy), heat energy, chemical energy, electrical energy and light energy.
Kinetic Energy: The energy of an object because of its motion is called its kinetic energy. Its SI unit is Joule (J). A flying bird, a running man, a moving train and a swinging bat are some examples of bodies with kinetic energy. Kinetic energy of a body moving with certain velocity is equal to the work done on it to make it acquire that velocity. Kinetic energy of an object increases with its speed:
• Due to kinetic energy, a bullet fired from a gun can pierce a target.
• A moving hammer, drives a nail into a wooden block. Due to its motion, it has kinetic energy or ability to do work.
The kinetic energy of a body of mass m moving with a speed v is 1\2 mv^2
Sometimes a large rock from space hits the earth's surface at a very high speed. Its huge kinetic energy creates a large crater on the earth's surface. One such crater was formed thousands of years ago at Lonar in Maharashtra. The diameter of this crater is 1.8 km.
Expression for kinetic Energy: Suppose a body of mass "m" moving with a uniform velocity "u". Force "F" starts acting on it in the horizontal direction and displaces

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it through a distance of "s" and it attains a velocity "v". Then, work done to increases its velocity from "u" to "v".

According to equation of motion: $v^2 - u^2 = 2as$

As the object starts from rest so u = 0 and if the distance is x, So

$v^2 = 2ax$ (1)

According to the definition of Fore

F = ma

Or a= F/m

Putting the value of F in the Equation (1), we get

$v^2 = 2(F/m)\,x$

or $F\,x = 1/2\,mv^2$

But Fx is the work done by the force on the body. It should be equal to the increase in the kinetic energy of the body as it moves from A to B. Also, since the kinetic energy at A was zero, the increase in kinetic energy should be equal to the kinetic energy at B. So, we conclude the following.

The kinetic energy of a body of mass m moving with a speed v is $1/2\,mv^2$

Kinetic energy = $1\backslash/2\,mv^2$

Example: Find the kinetic energy of a ball of mass 200 g moving at a speed of 20 cm/s.

Solution The kinetic energy is $KE = 1/2\,mv^2$

Given m= 200g = 0.2 Kg

v = 20 cm/s = 0.2m/s

KE = $1/2\ (0.200\ kg) \times (0.20\ m/s)^2 = 0.004$ J.

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