

## Work/Energy : Notes-5

**Work** is defined by the formula:

$$\text{Work} = \text{Force} \bullet \text{Distance}$$

That is; the work done on an object, is equal to the magnitude of the force acting on the object, multiplied by the distance through which it moves. (Note: The perpendicular component of the force does no work)

Example: If an object of mass  $m$  is lifted vertically through a height  $h$ , then the work done equals  $mgh$ . If  $h = 0.0\text{m}$ , then we say that the gravitational potential energy equals zero. At height  $h$ , the **gravitational potential energy** equals  $mgh$ .

$$\text{Work} = mgh = \Delta E_p$$

Example: If a force causes an object to move horizontally on a frictionless surface, then its velocity will increase. Recall the kinematics formula;  $V_f^2 - V_i^2 = 2ad$ . If the initial velocity ( $V_i$ ), is  $0.0$  m/s, and a force,  $F = ma$ , acts on the object over a distance  $d$ , then we have:  $mV_f^2 = 2mad$ , or  $(1/2)mV_f^2 = Fxd$ . The quantity,  $1/2mV^2$ , is called the **kinetic energy**.

$$\text{Work} = \frac{1}{2}mV^2 = \Delta E_k$$

When a ball is dropped, it loses gravitational potential energy, but what it loses in gravitational potential energy, it gains in kinetic energy. The total energy (kinetic + potential) is constant. One of the most important laws of physics is; **The Law of Conservation of Energy**. This law states that; energy cannot be created or destroyed. It can only change form. Mathematically, this law may be written as follows:

$$\frac{1}{2}mV_1^2 + mgh_1 = \frac{1}{2}mV_2^2 + mgh_2$$

This equation states that; for a body in motion, near the Earth's surface, the sum of the kinetic energy plus the potential energy of an

object near a point (1), is equal to the sum of the kinetic energy plus the potential energy at a different point (2). This assumes that only the force of gravity acts on the object.

If work is done on an object in a certain time, then the power is equal to the work done per unit time or the energy expended per unit time. The units are J/s or Watts (W).

$$\text{Power} = \frac{\text{Energy}}{\text{time}} = \frac{\text{Work}}{\text{time}}$$