Work Energy theorem :

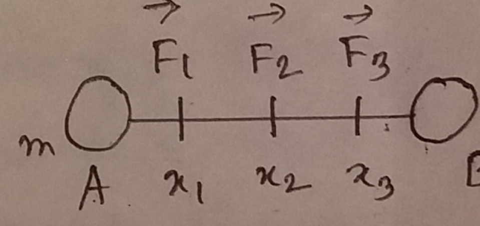
Statement :

"The workdone by the resultant force acting on a Particle is equal to the change in the kinetic energy of the Particle."

Although we have proved this result for constant force only, it holds whether the resultant force is constant or variable. Let the result vary in magnitude.

$$\text{so, } \int \vec{F} dx = \vec{F}_1 x_1 + \vec{F}_2 x_2 + \cdots\cdots + \vec{F}_n x_n \neq \text{const.}$$

Let this direction be the x axis the workdone by the resultant force in displacing the particle from x_0 to x is



$t = 0$	$t = t$
x_0	x
v_0	v

$$W = \int \vec{F} \cdot dx$$

$$= \int_{x_0}^{x} \vec{F} \cdot dx$$

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$$= \int_{x_0}^{x} m\vec{a}\,dx$$

From Newton's second law we have $F = ma$ and the acceleration a can be written as.

$$\vec{a} = \frac{dv}{dt}$$

$$= \frac{dv}{dx} \cdot \frac{dx}{dt}$$

$$= \frac{dv}{dx} \cdot v$$

$$= v\,dv/dx$$

Hence, $$W = \int_{x_0}^{x} \vec{F} \cdot dx$$

$$= \int_{x_0}^{x} m\vec{v}\,\frac{d\vec{v}}{dx}\,dx = \int_{v_0}^{v} mv\,dv = m\int_{v_0}^{v} \cancel{vdv}$$

$$= \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2 \qquad = m\left[\frac{v^2}{2}\right]_{v_0}^{v}$$

$$= K - K_0$$

$= \Delta K$ = change of kinetic energy.

$W = \Delta K$

(Proved)

Power:

Let us consider the time involved in doing work. The same amount of work is done in raising a given body through a given height whether it takes one second or one year to do so. However, the rate at which work is done is often more interesting than the total work performed.

We define power as the time rate at which work is done. The average power delivered by an agent is the total work done by the agent divided by the total time interval, or.

$$P = W/t$$

The instantaneous power delivered by an agent is

$$P = \frac{dW}{dt} \quad \text{--- (1)}$$

If the Power is constant in time, then and

$$W = Pt.$$

Unit: Watt.

1. Problem: A Net force 5 N acts on a 15 kg body initially at rest. Compute the work done in the first, second and third second and the instantaneous power that exist at the end of third second.

2. A Neutron, one of the constituents of a nucleus, is found to pass two points 6.0 meters apart in a time interval of 1.8×10^{-4} sec. Assuming its speed was constant, find its kinetic energy. The mass of a neutron is 1.7×10^{-27} kg.

Conservation of energy:

Energy, as we have noted, is conserved, making it one of the most important physical quantities in nature. The law of conservation of energy can be stated as follows:

Law of Conservation of energy:

"Total energy is constant in any process. It may change in form or be transferred from one system to another, but the total remains the same."

We have explored some forms of energy and some ways it can be transferred from one system to another. This exploration led to the definition of two major types of energy — mechanical energy (KE + PE) and energy transferred via work done by non conservative forces (W_{nc}). But energy takes many other forms, manifesting itself in many different ways, and we need to be able to deal with ~~...~~ all of these before we can write an equation for the above general statement of the conservation of energy.

At this point, we deal with all other forms of energy by lumping them into a single group called other energy (OE). Then we can state the conservation of energy in equation form as

$$KE_i + PE_i + W_{nc} + OE_i = KE_f + PE_f + OE_f$$

All types of energy and work can be included in this very general statement of conservation of energy. Kinetic energy is KE, work done by a conservative force is represented by PE, work done by non conservative force is W_{nc}, and all other energies are included as OE. This equation applies to all ~~...~~ examples; in those situations OE was constant, and so it subtracted out and was not directly considered.

Example: When a person eats, Food is oxidized with the release of carbon dioxide, water, and energy. Some of this chemical energy is converted to kinetic energy when the person moves, to potential energy when the person changes altitude, and to thermal energy (another form of OE).
