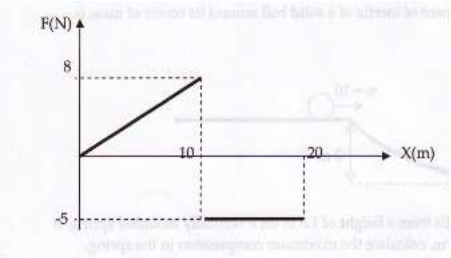
Q- The force verses displacement graph for a variable force acting on a particle during some displacement is given bellow (the thic lines)



(a) Calculate the total work done by this force on the particle.

(b) Which well-known physical device could produce the type of force during the first 10 seconds? Explain

When a force is applied to a body and body is displaced we say that the force did physical work.

The work done by a force is directly proportional to force and also to displacement and hence measured by the product of force and the displacement.

$W = F*x$

As force and displacement both are vectors while their product is scalar hence the product should be a dot (scalar) product and hence we write

$$W = \vec{F} \cdot \vec{x}$$

Now if force is not constant but varying with x (or a function of x) we will find the work done of infinitesimally small displacements and add or we can write

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

If the force is varying uniformly (linearly) with x, we may find the work by the product of average force and the displacement (if both are in same direction)

Solution:

(a) As the force is varying linearly for first ten meters from 0 to 8 N and hence the average force on the body is

$F_{av} = (0+8)/2 = 4$ N

The displacement during this phase is $\Delta x_1 = 10 - 0 = 10$ m

Hence the work done by the force for first phase will be

$W_1 = F_{av}*\Delta x_1 = 4*10 = 40$ J

For the second phase the force is constant and equal to -5 N (negative means the direction is opposite to the direction of displacement)

And the displacement during this phase is $\Delta x_2 = 20 - 10 = 10$ m

Hence the work done by the force during second phase will be

$W_2 = F*\Delta x_2 = (-5)*10 = -50$ J

Thus the total work done by the force on the body is given by

$W = W_1 + W_2 = 40 + (-50) = -10$ J

(The negative sign of the work done shows that the work is done against the force)

(b)

The simple physical device which can produce this type of force which increases linearly with displacement is an elastic spring. According to Hook's law the tension in the spring is proportional to extension in it hence as one end of the spring is fixed and the other is displaced the force applied by the spring varies with displacement of the other end given by

$F = K \Delta x$

Where K is the constant of proportionality called force constant of the spring.