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CLASS 11 & 12th



Learning Inquiry  
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CLASS 11th

# Work, Energy and Power

misostudy



## 01. Work Done

There are mainly three methods of finding work done.

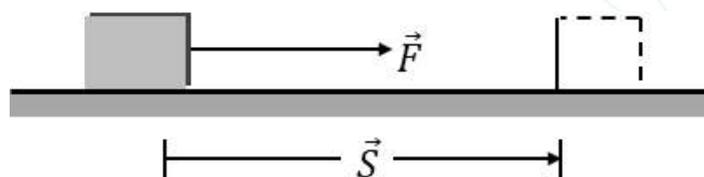
- Work done by a constant force ( $W = \vec{F} \cdot \vec{S} = FS \cos \theta$ ).
- Work done by a variable force ( $W = \int \vec{F} \cdot d\vec{S}$ ).
- Work done by area under F-S graph.

### (i) Work done by a constant force

Let us first consider the simple case of a constant force  $\vec{F}$  acting on a body. Further, let us also assume that the body moves in a straight line; in the direction of force. In this case we define the work done by the force on the body as the product of the magnitude of the force  $\vec{F}$  and the distance  $S$  through which the body moves.

This, in which the work  $W$  is given by

$$W = F.S$$



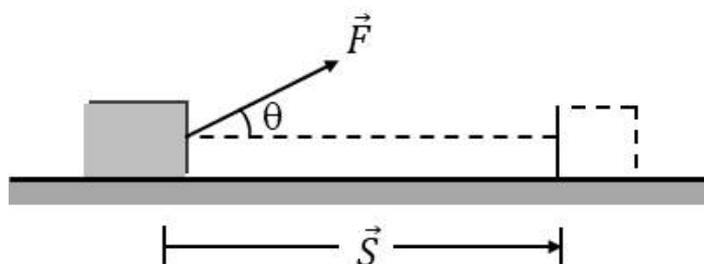
On the other hand, in a situation when the constant force does not act along the same direction as the displacement of the body, the component of force  $\vec{F}$  along the displacement  $\vec{S}$  is effective in doing work.

Thus, in this case, work done by a constant force  $\vec{F}$  is given by

$$W = (\text{component of force along the displacement}) \times (\text{displacement})$$

$$\text{or } W = (F \cos \theta) (S)$$

$$\text{or } W = \vec{F} \cdot \vec{S}$$



So, work done is a scalar or dot product of  $\vec{F}$  and  $\vec{S}$ .

Regarding work it is worth noting that:

- Work can be positive, negative or even zero also, depending on the angle ( $\theta$ ) between the force vector  $\vec{F}$  and displacement vector  $\vec{S}$ . Work done by a force is zero when  $\theta = 90^\circ$ , it is positive when  $\theta < 90^\circ$  and negative when  $\theta > 90^\circ$ . For example, when a person lifts a body, the work done by the lifting force is positive (as  $\theta = 0^\circ$ ) but work done by the force of gravity is negative (as  $\theta = 180^\circ$ ). Similarly work done by centripetal force is always zero (as  $\theta = 90^\circ$ )