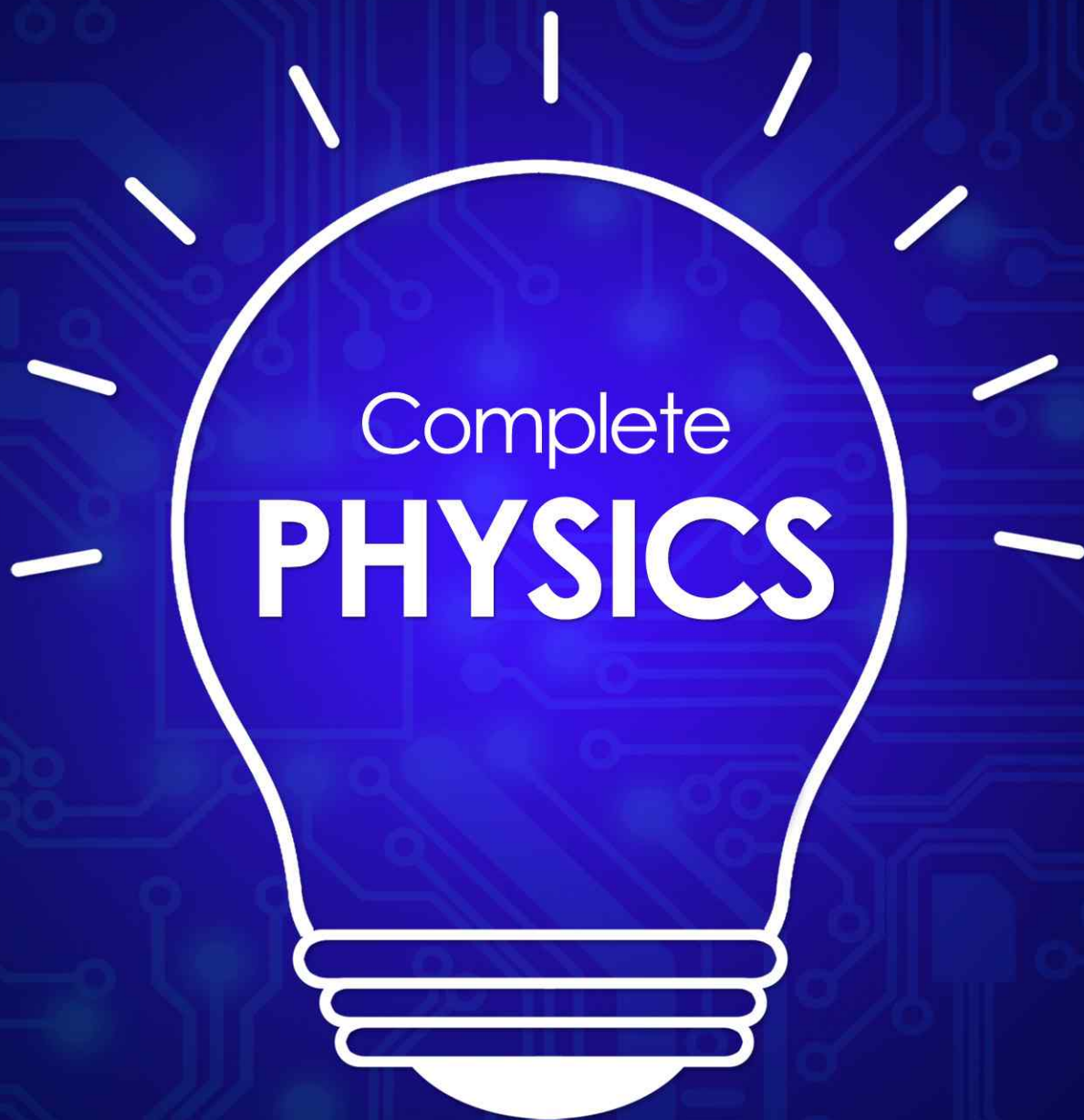




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CLASS 11 & 12th



Learning Inquiry
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CLASS 11th

Work, Energy and Power

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01. Work Done

There are mainly three methods of finding work done.

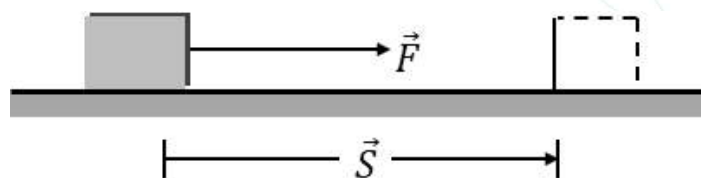
- (a) Work done by a constant force ($W = \vec{F} \cdot \vec{S} = FS \cos \theta$).
- (b) Work done by a variable force ($W = \int \vec{F} \cdot d\vec{S}$).
- (c) Work done by area under F-S graph.

(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, is the work W is given by

$$W = F.S$$



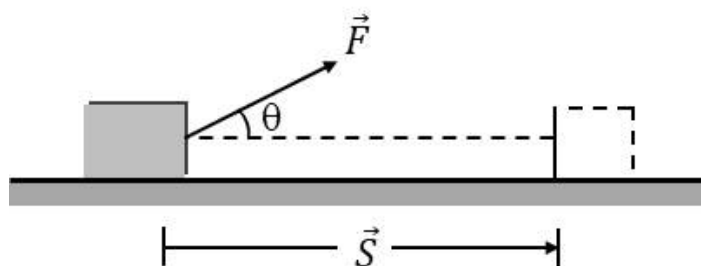
On the other hand, in a situation when the constant force does not act along the same direction as the displacement of the body, the component of force $\vec{F}$ along the displacement $\vec{S}$ is effective in doing work.

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

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

or $W = (F \cos \theta) (S)$

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:

- (a) Work can be positive, negative or even zero also, depending on the angle (θ) 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 $\theta = 90^\circ$)