Answer on Question #39010, Physics, Mechanics

Question

A block of mass 2 kg is pulled up on a smooth incline making angle 30 degrees with horizontal . if block moves with an acceleration of 1 m/s2 find

a) Power delivered by the pulling force at a time 4 sec after motion starts
b) average power delivered after 4 sec the motion starts

***MY DOUBT

I am very weak in kinematics , so plz explain that the formula s=ut+1/2at^2 gives displament or distance. and if it gives displacement then it will only give the length of base of the incline and not d length of hypotenuse which if needed?

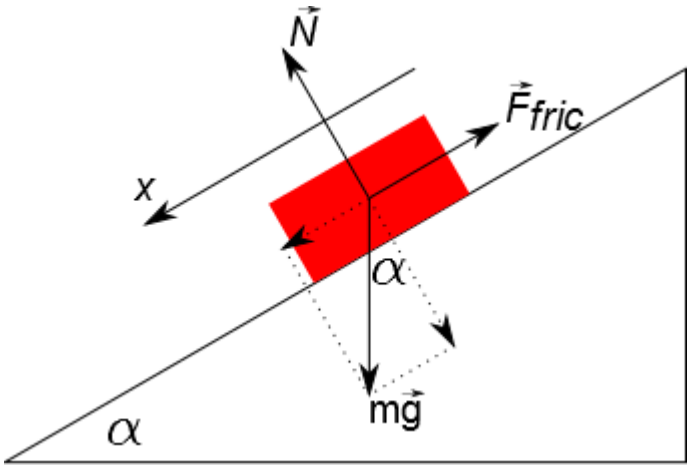
Answer

$m = 2\ kg$

$\alpha = 30^\circ$

$a = 1 m/s^2$

$t_0 = 4\ s$



a) By definition, power is

$$P = \frac{A}{t},$$

where A is work and t is time. We know that $A = Fs$, where s is distance covered by a block and F is a force acting on a block. Let us direct x axis along hypotenuse for simplicity. So, component of the gravitational force acting on the block is

$$F = ma = mg \sin\alpha - F_{fric},$$

see figure above. Because the friction force $F_{fric} = \mu N = \mu mg \cos\alpha$, $ma = mg \sin\alpha - \mu mg \cos\alpha \Rightarrow a = g(\sin\alpha - \mu \cos\alpha) = 1 m/s^2$,where μ is a coefficient of friction.

Formula $s = ut + \frac{at^2}{2}$, where u is the initial velocity and a is the acceleration can be used for motion in any direction. It gives displacement and if body does not change direction of motion one can use it for calculation of distance. In our case acceleration is directed along hypotenuse and $u = 0$, so it is convenient to use this formula for motion along x axis shown on the figure: $s = at^2/2$. We obtain:

$$P(t_0) = \frac{Fs}{t_0} = \frac{ma \cdot \frac{at_0^2}{2}}{t_0} = \frac{ma^2 t_0}{2} = \frac{2\ kg \cdot \left(1\frac{m}{s^2}\right)^2 \cdot 4\ s}{2} = 4\ W$$

b) Because $P(t) \sim t$ we can calculate average power as

$$\overline{P} = \frac{P(t=0) + P(t=t_0)}{2} = 2\ W.$$