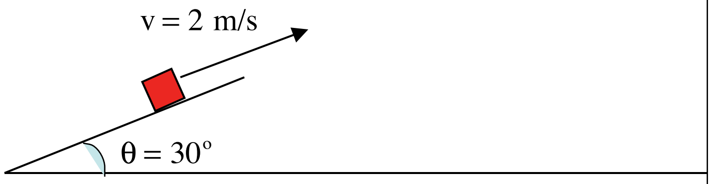
# Problem 5.50

A 70 kg skier is pulled 60 meters up a frictionless, $30^{o}$ hill with a constant speed of 2 m/s.




a.) How much work is required?

b.) What power is required of the motor?

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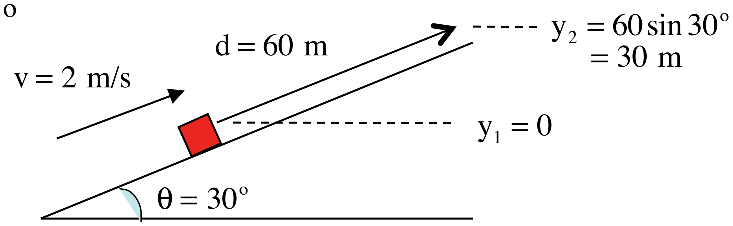


As the velocity is constant, the amount of work that the rope tow does must be equal and opposite the amount of work gravity does (net work equals the change of kinetic energy, which is zero). That means all we need is the amount of work gravity does, or:

$$
\begin{aligned}
W_{\text{tow rope}} &= -W_g = -(-\Delta U) \\
&= (mgy_2 - mgy_1) \\
&= mg(y_2 - y_1) \\
&= (70 \text{ kg})(9.8 \text{ m/s}^2)(30 - 0) \\
&= 20580 \text{ joules}
\end{aligned}
$$

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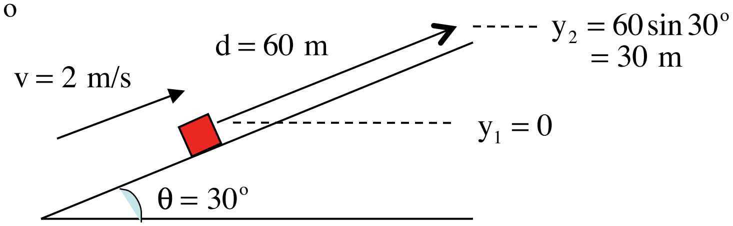


b.) What power is required of the motor?

The definition of power is "work per unit time," or: $P = \frac{W_{\text{tow rope}}}{t}$

Unfortunately, we don't know "t." An alternative form is: $P = \frac{W_{\text{tow rope}}}{t} = \frac{Fd}{t} = Fv$

To get F, we have to use the work relationship on the tow rope, or:

$$
\begin{aligned}
W_{\text{tow rope}} &= F_{\text{tow}} d \\
\Rightarrow \quad F(60 \text{ m}) &= 2058 \text{ joules} \\
\Rightarrow \quad F &= 343 \text{ nt}
\end{aligned}
$$

With the force, we can write:

$$
\begin{aligned}
P &= Fv \\
&= (343 \text{ nt})(2 \text{ m/s}) \\
&= 686 \text{ nt} \bullet \text{m/s} \\
&= 686 \text{ watts}
\end{aligned}
$$