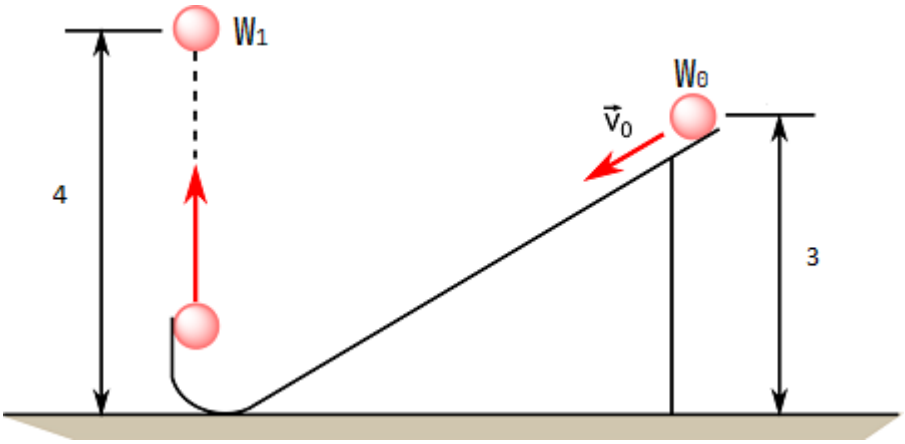
Physics Sample Problems

In this section, problems for each topics are provided to help train the application of the formulas.

Energy related problems

Problem 1: Ball speeding down the runway

A ball starts from a runway at a height of `3.00 m`. It gains speed before being launched directly upwards reaching a height of `4.00 m`. Ignoring friction and air resistance, find the initial speed of the ball $\overrightarrow{v_0}$.



Solution

One thing you can note first is that the height of the start of the ramp is different from the height the ball actually reaches.

This means surely **extra energy is applied** at the start of the ramp.

By the law of conservation of energy, the energy of the ball at the start must be equal to when it is at the peak. W_0 is the energy of the ball at the start, W_1 is the energy of the ball at the peak in the air.

$$W_0 = K_0 + U_0$$

$$W_1 = U_1$$

The reason W_1 only has U_1 in the equation is because when a particle has reached its peak in the air, all the kinetic energy has been converted to gravitational potential energy.

With these 2 equations, all we need to do is substitute any K and U where possible.

$$W_0 = \frac{1}{2}mv^2 + mgh$$

$$W_1 = mgh$$

Using the given variables

$$W_0 = \frac{1}{2}mv^2 + m(9.8)(3)$$

$$W_1 = m(9.8)(4)$$

Because we can ignore **air resistance** and **friction**. Then due to the conservation of energy, $W_0 = W_1$.

$$m(9.8)(4) = \frac{1}{2}mv^2 + m(9.8)(3)$$

Simply solve for v using algebra and we have our answer.

$$v = 4.427$$

Problem 2 Staircase Marathon

A person weighing `50.0 kg` decides to climb up the stairs of a temple `443.0 m` tall. In `15 minutes`, what must be the average power output of the person to be able to complete the staircase in time? Express your answer in watts

and horsepower.

Solution

This is simple, first find the potential energy the person would have gained at the top.

Using $W = mgh$

$$W = 50 \times 9.8 \times 443 = 217070J$$

After calculating the energy, simply divide it by 15 minutes, or 900 seconds.

$$P = \frac{217070}{900}$$

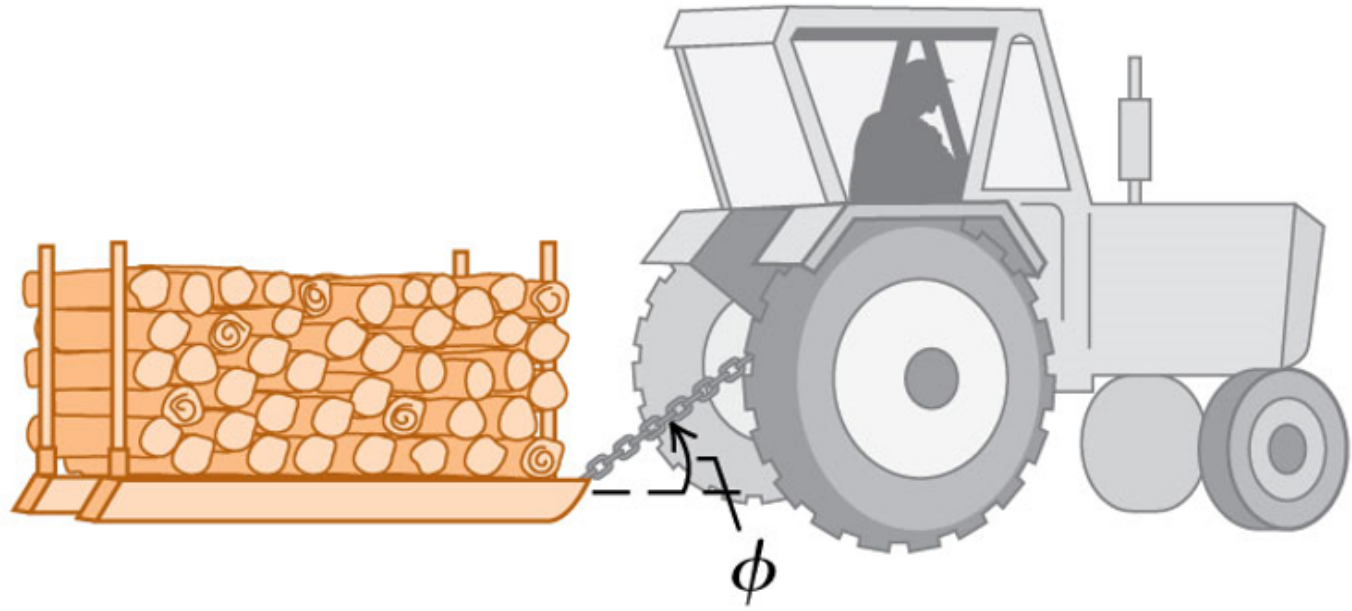
$$P = 241.19\ W$$

Just like that we have power, one horsepower is 745.7 Watts.

$$241.19\ W = 0.323\ HP$$

Problem 1: Tractor pulling a firewood sled

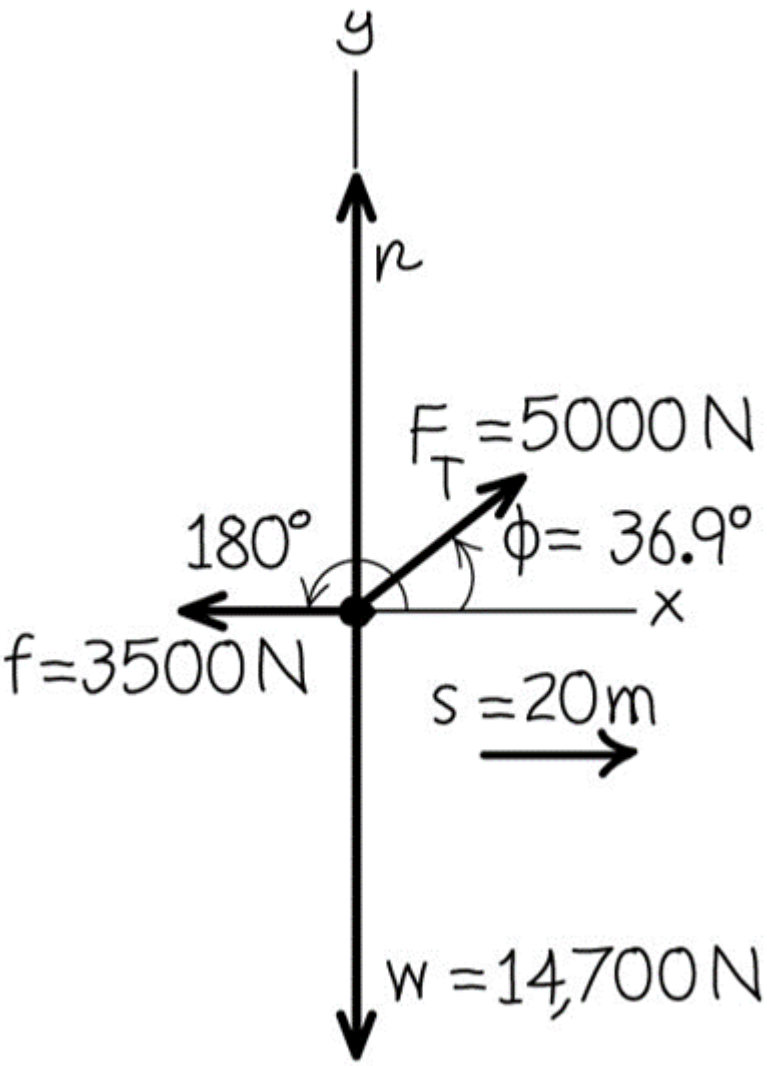
A farmer is pulling a sled of firewood `20.0 m` along level ground. The sled weighs `14700.0 N`. The tractor exerts a constant `5000.0 N` force at an angle of `36.9°` above the griybd. A `3500.0 N` friction force opposes the sled's motion.



Find the overall work done on the sled.

Solution

First, create a free body diagram to illustrate the forces on the sled.



> The forcces we can note are the **friction**, **tension** from the tractor, and the **weight**. Because work done is calculated using forces parallel to the direction of the displacement, we can effectively ignore **weight**. Do note things are different if the sled was inclined.
>
> To calculate the resultant force, we need to sum the resultant forces up:
>
> $$\sum F = 5000 \times cos(36.9 \backslash \text{degree}) - 3500 = 498.42$$
>
> *Remember that the 5000N force is not perfectly parallel, so some parts of it are acting parallel and some are perpendicular. Use trigonometry to figure out the individual components.*
>
> After getting the total force, simply multiply by distance to get work done
>
> $$W = 498.42 \times 20 = 9968.4J$$

You have reached the end