Work and Energy

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When lifting or pushing an object, more work is exerted when:

- an object is heavier.

- the object needs to be lifted higher.

For cases where force is constant, we define work as the product of the force exerted on an object and the distance the object moves in the direction of the applied force.

$$W = Fd$$

Work is a scalar quantity, it has no direction. Both force and direction here are *magnitudes only*

The SI unit for work is the joule where

1 joule = 1 newton•meter (N•m)

Work is only done:

- if the object is moving.

- if both the force and displacement are in the same direction.

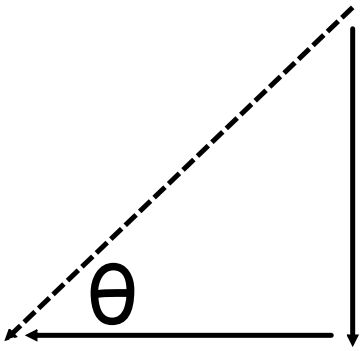
Example Problem

A student lifts a box of books that weighs 185 N. The box is lifted 0.800 m. How much work does the student do?

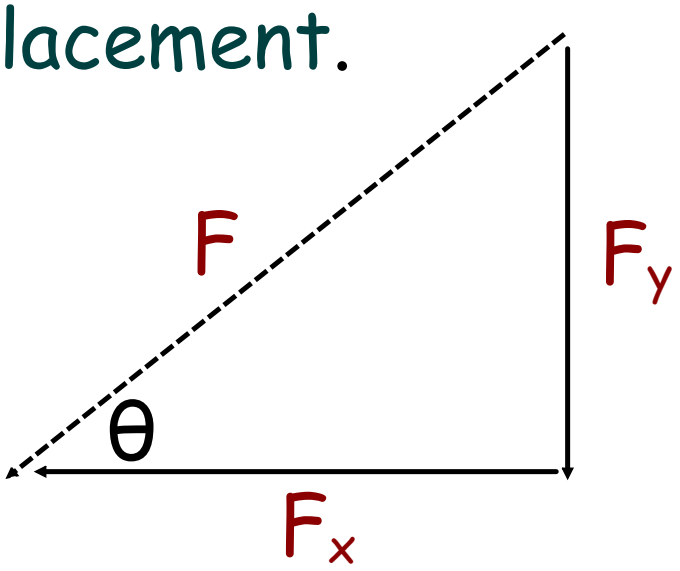
Work and Direction of Force

Remember, in order for work to be done the force must be in the direction of the motion.

What about mowing a lawn?



On an incline, the vertical force will do no work because it is not in the direction of the displacement.



F_x =

Substituting this into our work equation, we see that

$W = Fd$

$W =$  d <---------- (horizontal component - on an incline)

$W =$  d

$W =$ 

What other forces are exerted on the lawn mower if it moves at a constant speed?

Remember, if an object moves at constant speed then the net force must be zero.

In this case, $W = -F_f d$

When you move an object using work, you give it **energy**.

- by picking up a box, energy is transferred from you to the box

In this sense, work is the transfer of energy by mechanical means.

Example

A sailor pulls a boat along a dock using a rope at an angle of 60.0^0 with the horizontal. How much work is done by the sailor if he exerts a force of 255 N on the rope and pulls the boat 30.0 m?

Power

Power factors how long work is being completed.

Power is the rate of doing work

$$P = \frac{W}{t}$$

where W is work. One **watt** is one joule of energy transfered in one second. Power is measured in watts (W). Because a watt is a small unit, power is often referenced in kilowatts (kW).

Example:

An electric motor lifts an elevator that weighs 1.20×10^4 N a distance of 9.00 m in 15.0 seconds.

a) What is the power of the motor in watts?

b) What is the power in kilowatts?

Problems:

Pg. 199-203 #1-12 and 1.1 - 1.4

*omit 8(c)