# Introduction to Physical Science

Work and Kinetic Energy

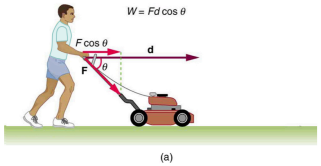
Presented by Robert Wagner

## Definition of Work

- What is work?
  - Product of force and the distance through which the force acts in the same direction
  - ; For this class, we consider 1 dimension so
  -
- If the force is not in the direction through which the object moves, no work is done. If the object does not move, no work is done
  - Units = =
  - Small amount of energy - would lift a 100 gram apple a distance of 1 meter

## Example

- How much work is done on the lawnmower by the person pushing it. The person exerts a force of 60.0 N over a distance of 25.0 meters.
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

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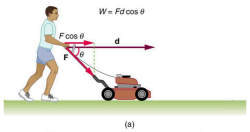
## Example




- How much work is done on the lawnmower by the person pushing it. The person exerts a force of 60.0 N over a distance of 25.0 meters.
  - Draw a sketch
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  - Enter values in the equation and solve

$F = 60.0\ N;\ d = 25.0\ m$

$W = F \cdot d$

$W = (60.0\ N)(25.0\ m)$

$W = 1510\ N \cdot m$

$W = 1510\ Joules$

Image Credit: OpenStax College Physics - Figure 7.2a CC BY 4.0

## What Happens to the Work Done?

- Suppose a lawnmower is pushed at a constant speed
  - The energy is converted to friction and then to heat
- Carrying an object up stairs
  - Converts the work into potential energy which is stored and can be released later
- Net Work: Net force causes acceleration
  -
  - Work-Energy Theorem
    -

## Kinetic Energy

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- This is the translational kinetic energy of an object with mass m, moving at velocity v in a straight line
- Kinetic Energy depend on the square of the velocity
  - Object moving twice as fast will have four times the kinetic energy

## Example

- A 30.0 kg package moves on a conveyor system at 0.500 m/s. What is the kinetic energy?
  - Draw a sketch
  - List known values ; identify unknown
  - Determine equation to use
  - Plug in known values and solve

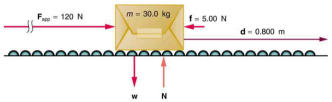


**Figure 7.4** A package on a roller belt is pushed horizontally through a distance **d**.

Image Credit: OpenStax College Physics - Figure 7.4 CC BY 4.0

## Example

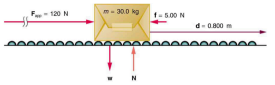


**Figure 7.4** A package on a roller belt is pushed horizontally through a distance **d**.

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$$m = 30.0\ kg\ ;\ v = 0.500\ m/s$$

$$KE = \frac{1}{2}mv^2$$

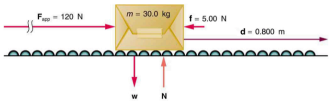
$$KE = \frac{1}{2}(30.0\ kg)(0.500\ m/s)^2$$

$$KE = 3.75\ Joules$$

Image Credit: OpenStax College Physics - Figure 7.4 CC BY 4.0

# Example

- A 30.0 kg package is pushed with a constant force of 120. N through a distance of 0.800 m. The frictional force opposing the motion is 5.00 N. What is the net work?
  - Draw a sketch
  - List known values ; identify unknown
  - Determine equation to use
  - Plug in known values and solve

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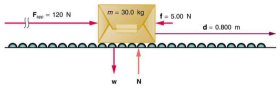



**Figure 7.4** A package on a roller belt is pushed horizontally through a distance **d**.

$m = 30.0\ kg\ ;\ F = 120.\ N\ ;\ d = 0.800\ m\ ;\ f = 5.00\ N$

$$F_{net} = 120.\ N\ -\ 5.00\ N = 115\ N$$

$$W_{net} = F_{net} \cdot d$$

$$W_{net} = (115\ N) \cdot (0.800\ m)$$

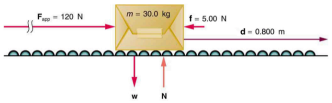
$$W_{net} = 92.0\ N \cdot m = 92.0\ Joules$$

No work done by the gravitational force or normal force as they operate perpendicular to the motion.

Image Credit: OpenStax College Physics - Figure 7.4 CC BY 4.0

# Example

- A 30.0 kg package is pushed with a constant force of 120. N through a distance of 0.800 m. The frictional force opposing the motion is 5.00 N. What is the final velocity?
  - Draw a sketch
  - List known values ; identify unknown
  - Determine equation to use
  - Plug in known values and solve

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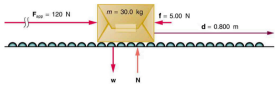


**Figure 7.4** A package on a roller belt is pushed horizontally through a distance **d**.

$KE_{initial} = 3.75\ Joules\ ;\ W_{net} = 92.0\ Joules$

$$KE_{initial} = \frac{1}{2}mv_o^2 = 3.75\ Joules$$

$$W_{net} = \frac{1}{2}mv^2 - \frac{1}{2}mv_o^2$$

$$\frac{1}{2}mv^2 = W_{net} + \frac{1}{2}mv_o^2 = 92.0\ Joules + 3.75\ Joules$$

$$\frac{1}{2}mv^2 = 95.75\ Joules$$

$$v = \sqrt{\frac{2(95.75\ Joules)}{30.0\ kg}} = 2.53\ m/s$$

Image Credit: OpenStax College Physics - Figure 7.4 CC BY 4.0

## Summary

- Work is defined to be the product of the force on an object multiplied by the distance through which the force acts
- The kinetic energy is the energy an object has due to its motion
- The Work-Energy theorem relates the net work to the change in kinetic energy