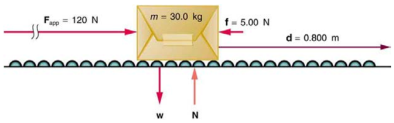
Kinetic Energy and The Work-Energy Theorem

LEARNING TARGET	DESCRIPTION
9.1	I can define, analyze, and calculate the amount of work done by a force in a closed system.
9.2	I can define, analyze, and solve problems involving kinetic energy.

Net Work vs Network

Suppose that you push on the 30.0-kg package with a constant force of 120 N through a distance of 0.800 m, and that the opposing friction force averages 5.00 N. Calculate the net work done on the package.



Net Work vs Network

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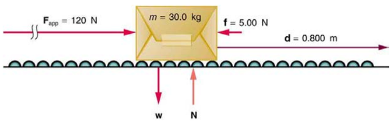
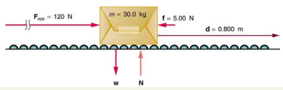


The net force is the push force minus friction, or $F_{net} = 120\text{ N} - 5.00\text{ N} = 115\text{ N}$. Thus the net work is

$$W_{net} = F_{net}d = (115\text{ N})(0.800\text{ m}) = 92.0\text{ N}\cdot\text{m} = 92.0\text{ J.}$$

Net Work vs Network



The applied force does work.

$$W_{app} = F_{app}d\cos(0^o) = F_{app}d = (120\text{ N})(0.800\text{ m}) = 96.0\text{ J}$$

The friction force and displacement are in opposite directions, so that $\theta = 180^o$, and the work done by friction is

$$W_{fr} = F_{fr}d\cos(180^o) = -F_{fr}d = -(5.00\text{ N})(0.800\text{ m}) = -4.00\text{ J.}$$

So the amounts of work done by gravity, by the normal force, by the applied force, and by friction are, respectively,

$$W_{gr} = 0,\quad W_N = 0,\quad W_{app} = 96.0\text{ J},\quad W_{fr} = -4.00\text{ J.}$$

The total work done as the sum of the work done by each force is then seen to be

$$W_{total} = W_{gr} + W_N + W_{app} + W_{fr} = 92.0\text{ J.}$$

SEMI TRUCK VS. VW BUG

A semi truck and VW Bug have the same kinetic energy. Which would cause more damage in a wreck?

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Same

VW BUG

A Volkswagon Bug (m=800 kg) is traveling down Grand Avenue at the speed limit (35 mph). How much kinetic energy does it possess?

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

VW BUG

A Volkswagon Bug (m=800 kg) is traveling down Grand Avenue at the speed limit (35 mph). How much kinetic energy does it possess?

$K = \frac{1}{2}mv^2 = \frac{1}{2}(800\text{ kg})(15.6\text{ m/s})^2$

$K = 97{,}000\text{ J}$

SEMI TRUCK

A Semi Truck (m=25,000 kg) has 97,000 J of kinetc energy. How fast is the truck traveling?

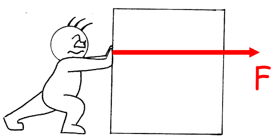
$K = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2K}{m}} = 2.8\text{ m/s}$

Work-Energy Theorem

When a force acts on an object over a distance, it is doing work on the object.

The result is a change in the speed of the object, and therefore a change in kinetic energy.



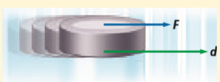
Work-Energy Theorem

$W_{total} = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

The total work done on an object is equal to the change in its kinetic energy.

EXAMPLE Problem 1

Work and Energy A 105-g hockey puck is sliding across the ice. A player exerts a constant 4.50-N force over a distance of 0.150 m. How much work does the player do on the puck? What is the change in the puck's energy?



$W = F \cdot d \cos\theta$

$W = 0.675\text{ J} = \Delta K$

$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2$

IN CLASS: Work-Energy Theorem

4. On October 9, 1992, a 27 pound meteorite struck a car in Peekskill, NY, creating a dent about 22 cm deep. The speed of the meteorite on impact is hypothesized to be about 550 m/s.

a) How much kinetic energy did the meteorite have before it struck the car?

b) How much work does the car do on the meteorite during impact?

c) What was the average force exerted on the meteorite by the car?

IN CLASS: Work-Energy Theorem

4. On October 9, 1992, a 27 pound meteorite struck a car in Peekskill, NY, creating a dent about 22 cm deep. The speed of the meteorite on impact is hypothesized to be about 550 m/s.

a) How much kinetic energy did the meteorite have before it struck the car?

$K = \frac{1}{2}mv^2 = \frac{1}{2}(12\ kg)(550\ m/s)^2 = 1.8 \times 10^6\ J$

b) How much work does the car do on the meteorite during impact?

$W = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_o^2$

$W = \frac{1}{2}(12\ kg)(0\ m/s)^2 - \frac{1}{2}(12\ kg)(550\ m/s)^2$

$W = -1.8 \times 10^6\ J$

c) What was the average force exerted on the meteorite by the car?

$W = F\ d$

$F = W/d = (-1.8\times10^6\ J) / (0.22m) = 8.2 \times 10^6\ N$

Meteor Impact

$v^2 = v_o^2 + 2ad$

$F = ma$

practice.

UNIT 9 PROBLEMS (8-11)