Name: ____________________

Period: ____________________

Conservation of Energy

Law of Conservation of Energy: $E_{before} = E_{after}$
"Energy is never created nor destroyed, just transformed into other forms of energy."

Energy Before Equals Energy After

Conservation of energy means energy is saved, retained. All the energy before an energy transformation must equal all of the energy afterwards OR $E_{before} = E_{after}$.

When an object falls or rises without friction, potential energy becomes kinetic energy.

Just put in the equations for each kind of energy!

$$Ep_{top} = Ek_{bottom}$$

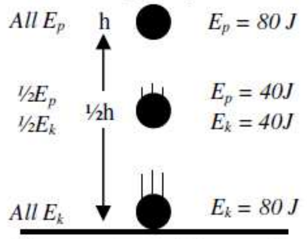
$$mgh = \frac{1}{2}mv^2$$

Mathematically the mass cancels: ***you don't need to know the mass!***

$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$$

$$gh = \frac{1}{2}v^2$$

The total energy stays constant.



By Conservation of Energy if you know the height of the object at the top, you can find its speed at the bottom and vice versa!

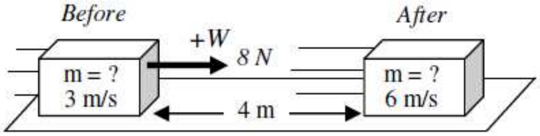
By setting the energies equal to each other, we can solve complex problems easily.

Ex. A 4 kg ball is thrown 6 m/s into the air. How high does the ball go?	
m = 4 kg v = 6 m/s h = _____	$E_{before} = E_{after}$ $E_k = E_p$ $\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$ $\frac{1}{2}(6)^2 = 10h$ $\frac{1}{2}(36) = 10h$ $18 = 10h$ $h = 1.8$ m

Changing Energy Takes Work

If energy is gained or lost during a transfer $E_{before} \neq E_{after}$. In order to change an object's energy work must be done, whether positive or negative. So, actually EB ± W = EA.

If the object's energy increases, add work: $E_{before} + W = E_{after}$.



$$Ek_{before} + W = Ek_{after}$$

$$\frac{1}{2}mv_b^2 + Fd = \frac{1}{2}mv_a^2$$

$$\frac{1}{2}m(2)^2 + 8(4) = \frac{1}{2}m(6)^2$$

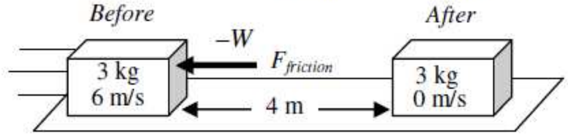
$$\frac{1}{2}m4 + 32 = \frac{1}{2}m(36)$$

$$2m + 32 = 18m$$

$$32 = 16m$$

$$m = 2kg$$

If the object's energy decreases, subtract work: $E_{before} - W = E_{after}$.



$$Ek_{before} - W = 0 \text{ (at rest)}$$

$$\frac{1}{2}3(4)^2 + F6 = 0$$

$$\frac{1}{2}3(16) + 6F = 0$$

$$3(8) + 6F = 0$$

$$24 + 6F = 0$$

$$6F = -24$$

$$F = -4\,N$$

E_{before} OR E_{after} can = 0.

"It starts moving" $Ek_{before} = 0$.

"It stops moving" $Ek_{after} = 0$.

"It starts on the ground" $Ep_{before} = 0$.

"It ends up on the ground" $Ep_{after} = 0$.

Efficiency

Efficiency tells you how much energy was retained in an energy transfer and how much was lost as friction. In any energy transfer, it is impossible to have an efficiency greater than 100%.

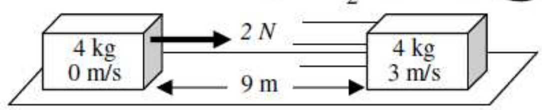
Efficiency (in %) → $$Eff = \frac{W_{out}}{W_{in}} x100$$
Work out (in J); Work in (in J)

Efficiency equals the Work out (or Energy gained) divided by the Work in (or Energy in) multiplied by 100.

If all of the energy is transferred, then the transfer is 100% efficient and no energy was lost to friction.

$$W_{in} = Fd \qquad W_{out} = E_k = \frac{1}{2}mv^2$$

$$W_{in} = 2(9) = 18J \qquad \frac{1}{2}4(3)^2 = 2(9) = 18J$$

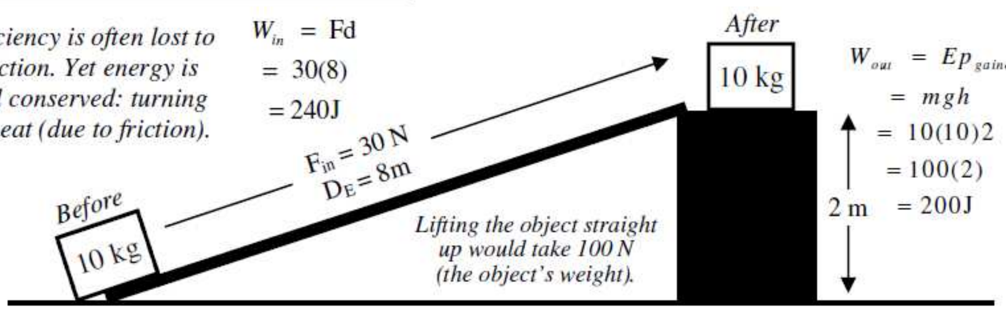


W_{in} vs W_{out}

W_{in} is the energy added to the object to lift or move it. W_{out} is the E_p or E_K it gains from W_{in}.

Efficiency is often lost to friction. Yet energy is still conserved: turning to heat (due to friction).

$$W_{in} = Fd = 30(8) = 240J$$



Lifting the object straight up would take 100 N (the object's weight).

$$W_{out} = Ep_{gained} = mgh = 10(10)2 = 100(2) = 200J$$

$$Eff = \frac{Wout}{Win} = \frac{Ep}{Win} = \frac{200}{240}x100 = 83\%$$

Friction took 17% of the energy, but it still felt easier, because it took less force!

Is work positive, negative, or zero?

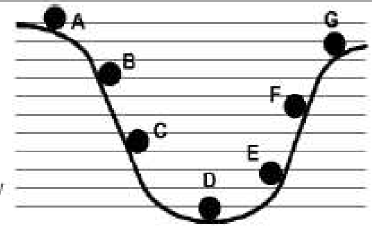
____ An object speeds up.
____ An object is lowered back to the ground.
____ Friction slows down an object.
____ An object slides down a ramp without friction.
____ An object is lifted up from the ground.
____ An object is thrown into the air without friction.

An object falls from A to D.

What kind of energy before?

What kind of energy after?

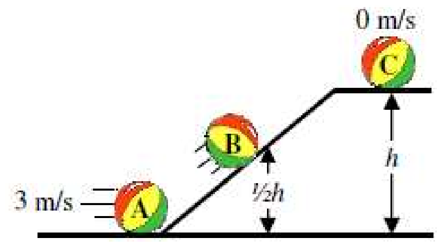
Put these together into the Law of Conservation of Energy.



1. $E_p = E_k$	A. A moving object stops.
2. $E_k = E_p$	B. An object at rest is moved by a force.
3. $E_{k\,before} + W = E_{k\,after}$	C. An object is thrown into the air.
4. $0 + W = E_{k\,after}$	D. A force speeds up an object.
5. $E_{k\,before} - W = E_{k\,after}$	E. An object slows down.
6. $E_{k\,before} - W = 0$	F. An object is lowered to the ground.
7. $E_{p\,before} - W = 0$	G. An object falls.

Find the energy of the 2 kg object at A.

Ep at C =
Ek at C =
Ek at B =
Ep at B =



A 5 kg rock is 8 m above the ground. Calculate its energy.

If it falls $E_{k\,bottom}$ =

Half-way down, Ek =

If you had an efficiency greater than 100%, what would be greater W_{in} or W_{out}?

Why is this not possible?

A 4 kg rock is dropped from 5 m. There is no friction.

A) What kind of energy does it have before? E_{before} =

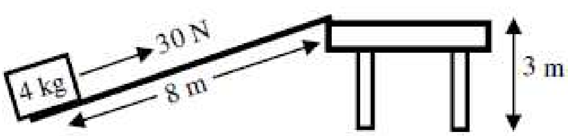
B) What kind of energy does it have after? E_{after} =

C) Does $E_{before} = E_{after}$

D) Was work done?

E) Put the above into the Law of Conservation of Energy.

F) *Solve for the speed of the object at the bottom.*



What is W_{in}?
Calculate W_{in}.

What is W_{out}?
Calculate W_{out}.

Calculate Efficiency.

An 8 kg box at rest on the ground is pushed by a force for 12 m. The box ends up going 3 m/s (and there is no friction).

A) E_{before} =

B) E_{after} =

C) Does $E_{before} = E_{after}$?

D) Put the above information into the Law of Conservation of Energy equation.

E) *Solve for the force.*

A 8 kg box at rest is pushed for 10 m with a 60 N force. If it is accelerated to 10 m/s. Calculate the efficiency of the force.