# TRAMPOLINE

## Interactive Physics Simulation

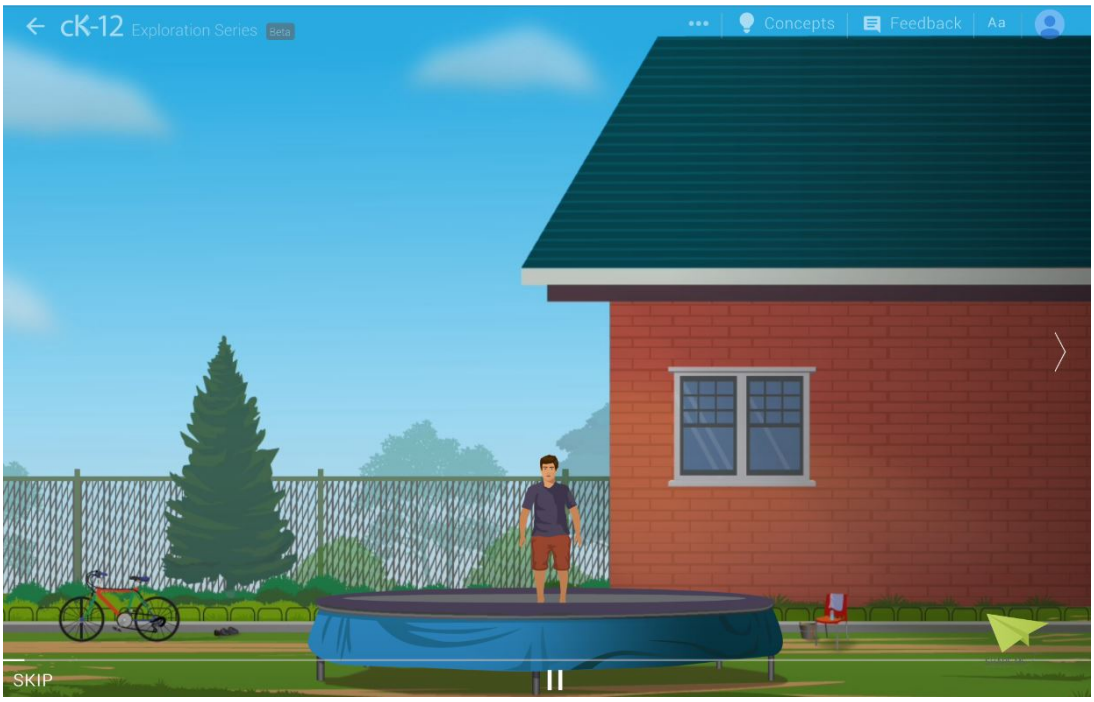
To visit this simulation :

http://interactives.ck12.org/simulations/physics/trampoline/app/

## Intriguing Question

**How are potential and kinetic energy exchanged?**

## Illustrative Video



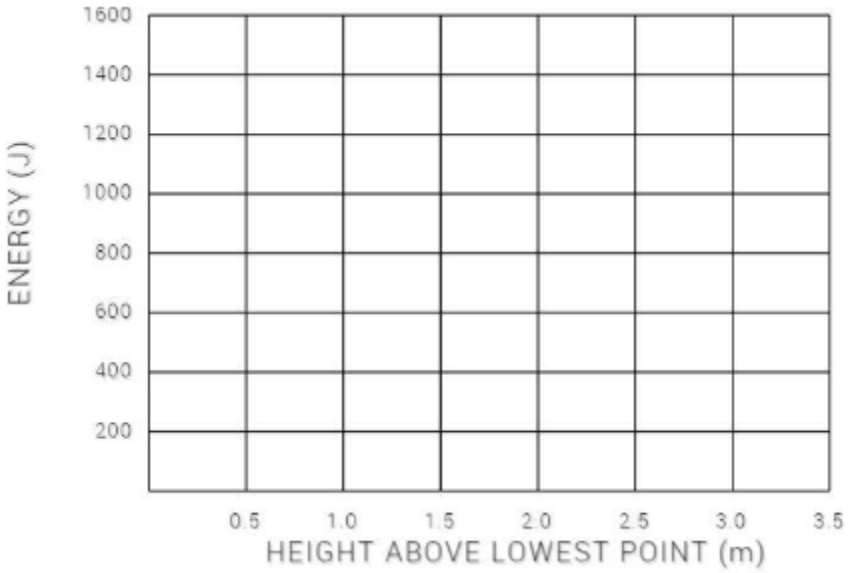

The trampoline is a fun (and sometimes hazardous) piece of equipment. As the jumper moves up and down, energy is exchanged between different types. A trampoline can store elastic potential energy, just like a spring. The amount of energy stored depends on how far it is stretched. Eventually it stretches far enough to reduce the jumper's kinetic energy to zero. Since elastic forces are conservative, the energy can be released as kinetic, and the jumper bounces back up.

## Interactive Simulation

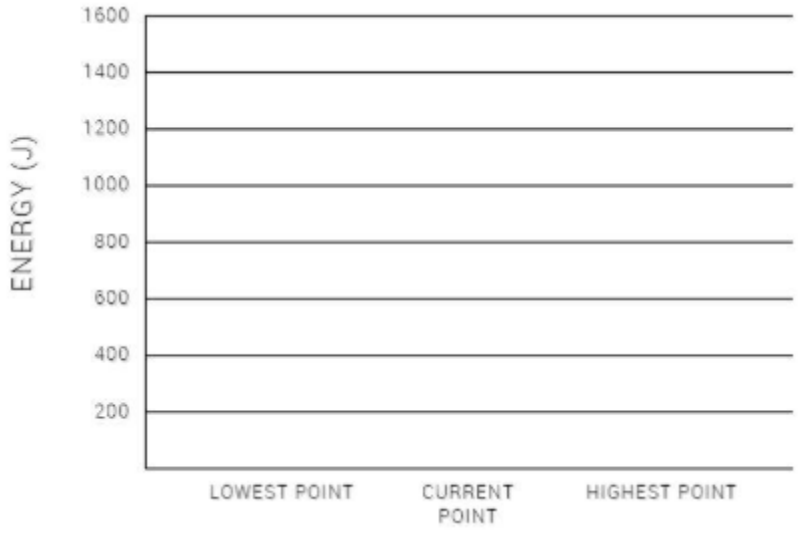

**Jumper Mass -** This slider adjusts the mass of the jumper. The gravitational potential energy and kinetic energy of the jumper are affected by the jumper's mass.


**Initial Height -** This slider adjusts the initial height of the jumper. This is a good way to increase the overall initial energy of the system. Because we have not programmed any (realistic) dissipative forces here, the jumper will keep reaching the same height.


**Trampoline Stiffness -** This slider adjusts the elastic stiffness (spring) constant of the trampoline. A higher stiffness means, for a given stretch, the trampoline will store more energy than for a lower stiffness.




**Energy vs. Height Above Lowest Point** - This is a plot of all the various forms of energy the jumper has at different heights. It might be a little hard to understand if you don't pause the simulation to slow down everything that's going on. Notice that the elastic potential energy is only important when the trampoline is actually stretching. As the jumper rises into the air, kinetic energy is exchanged for gravitational potential energy.




**Energy Bar Graph** - This is a plot demonstrating how the total energy of the system is broken into different components at different times in the jumper's trajectory. Pause the simulation to get a better look at this graph.

## Interpreting Results

- Adjust the sliders to maximize the total energy in the system. *(Adjust the jumper mass, initial height, and trampoline stiffness so that the total energy, as show in the both graphs, it at its greatest possible value.)*

- Adjust the sliders to maximize the initial gravitational potential energy of the jumper. *(The equation for gravitational potential energy is PE = mgh. )*

- Adjust the trampoline stiffness to maximize the elastic potential energy stored in the trampoline. *(The trampoline stiffness slider adjusts the elastic (spring) constant of the trampoline. You can set the jumper mass and initial height to any value.)*

## Challenge ME!

- At what point is the jumper moving most quickly? Is it right when the jumper hits the trampoline, or at some point after that?

- Can you determine the elastic constant of the trampoline using the provided data?

- Predict the speed of the jumper when he is moving most quickly.

## Need Help?

Check out the Trampoline Walkthrough video at: https://youtu.be/6oYIqFLOR64

## Interesting Questions

### Why are molecules a certain size?

When atoms interact to form molecules, they both attract and repel one another due to the presence of negatively charged electrons and positively charged protons. The electrons all repel one another, as do the protons. But the electrons and protons attract one another. Just as a person standing on a trampoline feels an upward push due to the trampoline and a downward pull due to gravity, and therefore feels an equilibrium between the two, so an atom feels both repulsion from and attraction to other atoms. It finds an equilibrium point between, and this “sets” the size of the molecule.

### Does the moon have potential energy?

Yes - the moon has a LOT of potential energy - imagine if you dropped it and it fell to Earth - that would involve so much energy, it would likely destroy both worlds. Even though the force of gravity gets weaker as you separate two objects, you are still storing more and more potential energy as you move them apart from one another. Similar things happen at the atomic level: the electrons farthest from the proton, where the pull is weakest, actually have the most potential energy.

### How far can you stretch a spring?

Within its ordinary range, springs act in very simple ways: the force they apply resisting a stretch is proportional to the amount of stretch. This is called Hooke's Law, and has been understood since the days of Isaac Newton. But - as you may know - when you pull a spring too far, it “deforms” and no longer behaves like an ideal spring. At the deformation limit, the metal in the spring starts to feel more “malleable” and can act something like putty - stretching thinner and longer than you'd expect.

### Why are trampolines considered dangerous?

Each time you push with your legs, you are adding energy to the system that comes from your cells - you stored this energy when you digested food. This energy is converted to mechanical forms: you bounce higher, you travel faster. If you then make a mistake, for instance bouncing the wrong direction, you might fall from the trampoline. Now you need to get rid of this energy to come to a stop - sometimes this energy is absorbed by your bones and flesh, causing injury.

## Physics Concepts | Click on the link below to learn more.

- Potential Energy - http://www.ck12.org/physics/Potential-Energy/
- Energy - http://www.ck12.org/physics/Energy/
- Forms of Energy - http://www.ck12.org/physics/Forms-of-Energy/